

Division of Aquatic and Wildlife Resources

Guam Department of Agriculture



Annual Report Fiscal Year 1998

Guam
Aquatic
and
Wildlife
Resources
Annual
Report
FY'98

ANNUAL REPORT FISCAL YEAR 1998

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TABLE OF CONTENTS

FY 1998

Page

Section I Coordination and Administration – Project FW-3C-6
(Federal Aid in Sport Fish and Wildlife Restoration Acts)

Job C-1-1	Coordination of Guam's Fish and Wildlife Programs	1
Job C-3-1	Public Information and Education of Guam's Fish and Wildlife Restoration and Endangered Species Programs	4

Section II Guam Fisheries Investigations – Project F-1R-6
(Federal Aid in Sport Fish Restoration Act)

Job F-1-1-1	Offshore Fisheries Survey	7
Job F-1-1-2	Inshore Fisheries Survey	17
	Inshore Aerial Survey (Appendix 1)	29
	Kid's Fishing Derbies (Appendix 2)	32
Job F-2-1-1	Freshwater Monitoring	37
Job F-3-1	Technical Guidance to Projects Affecting Guam's Fish Resources	42
Job F-4-1-1	Stock Assessment Surveys of Marine Preserves and Control Sites	44

Section III Guam Fisheries Development – Project F-2-D
(Federal Aid in Sport Fish Restoration Act)

Job F-2-D-7	Merizo Pier and Boat Ramp Facility	48
Job F-2-D-9	Development of Inshore Fishing Access Facilities	50
Job F-2-D-10	Masso Reservoir Restoration	52
Job F-2-D-11	Fabrication and Deployment of Shallow Water Moorings	54
Job F-3-D-2	Maintenance and Redeployment of FADs and SWMs	61
Job F-4-D-1	Marine Fish Habitat Improvement and Aggregating Devices	67

Section IV Other Federally Funded Projects

CVA-1	Construction of Pumpout Facilities	71
-------	------------------------------------	----

Non-Federally Funded Projects

Commercial Fisheries on Guam	73
------------------------------	----

		Page
Section V	Guam Wildlife Investigation Project W-1R-6 (Federal Aid in Wildlife Restoration Act)	
Job W-1-1-1	Determination of Current Population Size and Distribution of Guam Deer	75
Job W-1-2-1	Population Size and Distribution of Wild Pigs on Guam	80
Job W-2-1-1	Population Numbers and Distribution of Philippine Turtle-Doves	83
Job W-2-2-1	Population Size and Distribution of Black Francolin on Guam	86
Job W-3-1-1	Population Size and Distribution of Wild Asiatic Water Buffalo on Guam	89
Job W-4-1-1	Survey and Inventory of Non-Game Birds Assessment of Damage to Guam's Natural Resources from Supertyphoon Paka (Appendix 1)	92 103
Job W-4-1-2	Survey for Mariana Crows and Their Nest Sites	108
Job W-5-1-1	Current Status, Distribution, and Natural History of Mariana Fruit Bats	117
Job W-6-1-1	Technical Guidance to Projects Affecting Guam's Wildlife Resources	124
Section VI	Guam Endangered Species Investigation Project E-2-1 (Section 6 – Endangered Species Act of 1973)	
Job A-1	Reproductive Biology of the Mariana Crow and Other Endangered Species	128
Job A-2	Area-Wide Control of Brown Tree Snakes	137
Job A-3	Translocation of Mariana Crows	142
Job B-1	Captive Propagation of Guam Rails and Other Native Species	143
Job B-2	Mariana Crow Avicultural Support	148
Job B-3	Captive Propagation of Guam Micronesian Kingfishers	149
Job C-1	Development of an Experimental Population of Guam Rails in the Commonwealth of the Northern Mariana Islands	152
Job D-1	Establishment of Populations of Endangered Species in Snake-Free Areas on Guam	160
	Lizard Trapping Results for Area 50, April-May 1997 (Appendix 1)	164
	Lizard Trapping Results for Area 50, April 1998 (Appendix 2)	170
	Small Mammal Survey Results for Area 50, February 1997 (Appendix 3)	174
	Small Mammal Survey Results for Area 50, April 1998 (Appendix 4)	177

JOB PROGRESS REPORT COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-3C-6
SUB-PROJECT NO.: C-1
JOB NO.: 1

JOB TITLE: Coordination of Guam's Fish and Wildlife Programs (1630, 2630)

PERIOD COVERED: October 1, 1997 to September 30, 1998

OBJECTIVES

To plan, coordinate, supervise, and administer all fish and wildlife restoration and endangered species programs.

PROCEDURES

1. Supervise the planning and documentation of the Fish and Wildlife programs.
2. Administer all fiscal and budgetary matters and coordinate with the Central Accounting and Budget Office.
3. Administer all personnel matters including recruitment of off-island staff.
4. Represent the Division and Department of Agriculture in all matters pertaining to Fish and Wildlife Resources.

RESULTS

The Division experienced several staff changes during the year. The position changes within the respective section are as follows:

Administration: Ester Morris was hired as a Clerk-Typist III in December 1997. Lillian Rebanio began a new Limited-Term appointment as a Clerk I in February 1998.

Wildlife: The endangered species program experienced a number of staff changes during the year. Rebecca Caballero joined the staff as a Technician in January 1998 and Biologist Alicia Dimarucut and Technician Michelle Pleskonko resigned in October 1997 and Biologist Mark Richman resigned in January 1998.

Jeffrey Quitugua was promoted to Biologist I but then resigned in August 1998 to fulfil his Teacher Corps obligation with the Department of Education.

Biologist I Allen Searle was hired November 1997 to work in the brown tree snake program.

Fisheries: In January 1998, Catherine (Trina) Leberer was hired as a Fisheries Biologist II assigned to freshwater monitoring and Rodney Brent Tibbatts and Jaime Bass were hired as Technicians.

Division staff spent the first quarter preparing the annual Job Progress Reports on the research and other activities conducted during FY97 under its various federal programs and submitted them to the US Fish and Wildlife Service Regional Office.

Staff also devoted considerable effort to preparing the Federal Aid project documentation necessary to obligate funds for the Division's various programs during FY99. This documentation included annual Grant Agreements for 1) Project FW-3C, Guam Fish and Wildlife Coordination, which covers the administration and coordination of the Division's Federal Aid programs and which is jointly funded by Wildlife (PR) and sport fisheries (DJ) funds; 2) Project F-1R, Guam Sport Fish Investigations, which covers sport fish research and survey activity and which is funded with sport fisheries (DJ) funding; and 3) Project W-1R, Guam Wildlife Investigations, which covers wildlife research and survey activity and which is funded with wildlife (PR) funds. In addition, annual Grant Agreements and Amendments were prepared for the Division's various Fisheries Development and Endangered Species Investigations (Section 6) projects.

The Mariana Crow Recovery Team (MCRT) met on Guam in early October, 1998 to consider the Division's 1997 request to amend the FWS Endangered Species subpermit for the Marianas Crow to allow translocation of adults, chicks and eggs from Rota to Guam to stimulate reproduction was resubmitted. In response to MCRT recommendations, a detailed "Translocation, Artificial Incubation, Hand-Rearing, and Releasing Plan for the Aga, *Corvus kubaryi*" and an "Area-Wide Snake Control Plan" were prepared and submitted. Although the MCRT endorsed the permit request, as of the end of the reporting period the permit had not been issued by the FWS, pending prior approval by the governments of both the CNMI and Rota.

The Division Chief and his staff represented the Division and the Department of Agriculture in all matters relating to fish and wildlife resources. This frequently entailed meetings with other agencies of the Government of Guam, various Federal agencies, and the military.

The Division's administration and coordination responsibilities are 50% funded by local funds.

The Chief served on the Area Committee for Oil Spill Response and continued to serve as a member of the Navy's Rehabilitation Advisory Board (RAB).. In addition, he is a member of the Criminal Justice Advisory Committee at Guam Community College. He is also a member of the Peace Officer Standards and Training Commission, as designated by law.

Division staff made a number of off-island trips related to Federal Aid and other programs. In many cases, funding support for this travel was provided through non-Federal Aid sources.

Division Chief Robert Anderson and Fisheries Supervisor Gerry Davis attended Region 1 Federal Aid Coordinators Conferences in Kona, Hawaii in November 1997 and in Homer, Alaska in September 1998.

Division Chief Robert Anderson participated in the Brown Tree Snake Research Symposium in Honolulu, Hawaii in July 1998. In conjunction with that trip he attended the Hawaii Conservation Conference, held the following week.

Division Chief Robert Anderson and Wildlife Biologist III Kelly Brock attended a meeting of all participating zoos in the Guam rail captive breeding program at the San Diego Zoo in January 1998. This meeting was organized and chaired by Ms. Brock and hosted by the

San Diego Zoo. At the meeting, Ms Brock was selected to serve as the Species Coordinator for the Guam Rail Species Survival Program.

Division Chief Robert Anderson, accompanied by Biologists III Kelly Brock and Tino Aguon, traveled to Rota in February, 1998 to meet with the Mayor and Resident Director of Land and Natural Resources to discuss the Guam rail and Mariana crow translocation projects. The three made a second trip to Rota in early May to meet with the Mayor and Resident Director as well as the CNMI Secretary of Land and Natural Resources and Director of Fish and Wildlife from Saipan.

Fisheries Supervisor Gerry Davis served on a Saltonstall-Kennedy Grant review panel in Silver Springs, Maryland funded by the National Marine Fisheries Service in October 1997. In conjunction with that trip he also attended a Federal Data Coordinating Committee (FDCC) meeting in Hawaii, funded by a WPacFIN grant and the Region 1 Federal Aid Coordinators Conference in Kona, partially funded by a Sport Fish Restoration grant.

In July 1998, he attended another FDCC meeting in Hawaii, funded by WPacFIN grant money. In conjunction with that trip, he participated in a Sportfishing Symposium in Kona, Hawaii, funded by the sponsors of that event, and then attended a Sea Turtle Recovery Workshop in Honolulu, funded by the National Marine Fisheries Service.

Fisheries Biologist III Andrew Torres attended a Bottomfish Plan Monitoring Team meeting in Honolulu, Hawaii in February 1998 funded by the Western Pacific Regional Fisheries Management Council.

Fisheries Biologist III Tom Flores attended Pelagic Plan Monitoring Team meeting in Honolulu in May 1998 funded by the Western Pacific Regional Fisheries Management Council.

Fisheries Biologist III Todd Pitlik attended a Coral Plan Monitoring Team meeting in Honolulu in September 1997 funded by the Western Pacific Regional Fisheries Management Council.

Biologist III Tino Aguon participated in the Brown Tree Snake Research Symposium in Honolulu, Hawaii in July 1998.

Biologist III Gary Wiles traveled to Saipan in January 1998 to assist the Fish and Wildlife Service with surveys of the nightingale reed-warbler. Travel was paid for by the Service.

Biologist III Kelly Brock, Wildlife Biologist II Grant Beauprez, made numerous trips to Rota in support of the Guam rail introduction project. In addition to radio telemetry monitoring of released rails, they conducted rodent and predator trapping. Several staff members including: Biologist IV Robert Beck, Biologists II Mark Richmond and Suzanne Medina, Biologist I Lamont Henderson, and Technicians Chris Jones and Jeffery Quitugua visited Rota to provide additional support to the rail project.

Biologist III Kelly Brock attended the American Zoological Association Conference in Tulsa, Oklahoma in September 1997.

The Division hosted a number of off-island visitors during the year.

PROGRAM COST: The estimated cost of the project under FW-3C-5 is \$65,000.

This report was prepared by: Robert D. Anderson.

JOB PROGRESS REPORT INFORMATION/EDUCATION PROGRAM

STATE: Territory of Guam

PROJECT NO.: FW-3C-6
SUB-PROJECT NO.: C-3
JOB NO.: 1

JOB TITLE: Public Information and Education on Guam's Fish and Wildlife
Restoration and Endangered Species Programs (2520, 2530, 1630)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

The Natural Resource Information and Education Officer position approved by the Governor and the Civil Service Commission during FY97 was announced twice during FY98 but remains unfilled.

The Division sponsored two Kid's Fishing Derbies during FY98, one at Fena Lake at the Naval Ordnance Annex, and the other at Sirena Beach, Andersen Air Force Base.

The Division continues to distribute posters, flyers, pamphlets, coloring books and videos to the public and schools and continues to make classroom presentations at the island schools.

The Division continued to issue press releases on its projects and activities, set up static public displays, conduct press conferences, submit feature articles to the print media, make radio and television appearances, and respond to requests for information from students and members of the general public.

BACKGROUND

The Public Awareness and Conservation Education Program (PACE) was established in support of the Division's mission to protect, preserve, develop and enhance Guam's aquatic and wildlife resources. The program consists of school presentations dealing with aquatic and wildlife conservation, kids' fishing derbies, the production of resource materials for classroom use including coloring books, activity guides, posters and informational flyers, news releases, static public displays, public service announcements, press conferences and feature articles.

Up until FY90, the program was facilitated primarily by a Public Information Officer (PIO), and periodically by staff biologists. During FY90, Conservation Officers began providing direct support to the PACE effort by conducting classroom visits. The PIO position was vacated in late FY96 and since then the classroom visitation portion of the program has been supported by Fisheries and Wildlife Biologists as well as Conservation Officers.

The effectiveness of the PACE programs and activities can best be measured by the community's continuing response in reporting suspected poachers and poaching activities to conservation officers and police, the growing interest and demand for resource conservation materials, and the increase in teacher and student requests for fish and wildlife presentations. As in the past, residents continue to report bird sightings, bring in injured birds or birds presumed to be endangered species, and generally to encourage the

institution of more intensive management programs for Guam's fish and wildlife resources.

PROCEDURES AND RESULTS

The Division's activities and efforts during FY98 included the following:

1. Presentations on endangered species, coral reef ecology and fish and wildlife conservation in general were delivered public and private elementary schools, middle schools, and high schools, university classes, and groups such as the 4-H Club, Cub Scouts, and Department of Parks and Recreation Summer Camp. Presentations were usually accompanied by a live Guam rail, fruit bat, brown tree snake, monitor lizard, or various marine organisms, as appropriate. Conservation Officers alone conducted 20 classroom presentations, the Wildlife staff an equivalent number, and the Fisheries staff 47 more.
2. Continuation to distribute color posters on the reef and pelagic fishes of Guam to public upon request at the Division office and to replenish the posters previously supplied to every school classroom on Guam. The Sport Fish Restoration Program funded the development and production of the posters.
3. Continuation to distribute color posters on the Dangerous and Poisonous Sea Creatures to the public upon request. The production of the posters were funded by the Guam Coastal Zone Management Program, while DAWR provided some of the photographs and technical support.
4. Continuation to distribute color flyers of Guam's animal, plant and marine life to the schools and public upon request. The development and production of the flyers were funded by the PACE program, while printing was funded by the Coastal Zone Management Program.
5. Continuation to distribute color posters on the Mariana fruit bat (*Pteropus mariannus*) to the public upon request at the Division office and to replenish the posters previously supplied to every school classroom. The development and production of the posters were funded by the Wildlife Restoration Program; printing funds came from the Bureau of Planning's Coastal Management Program through a grant from the National Oceanic and Atmospheric Administration.
6. Continuation to distribute copies of a 30-minute video on coral reef ecology intended for use in public fisheries presentations and for distribution to school and public libraries, museums, and other educational institutions. In addition to this institutional distribution, free copies of the video are available to the public upon request at the Division office. The video was funded by the Sport Fish Restoration Program.
7. Displays on the brown tree snake the Guam Rail, and various other fish and wildlife conservation programs were set up during Earth Week, the University of Guam Charter Day, and other similar events.
8. Division programs and activities continue to gain extensive media coverage. Newspaper and television feature articles on Guam rail, Micronesian kingfisher and Mariana crow recovery efforts are periodically done, as are hunting and fishing activities and enforcement. In addition, a number of off-island media visited Guam during the year to film and document brown tree snake impact on Guam's natural resources and efforts to control its spread to other islands.

9. Participation in Youth Leadership Day activities and hosted one University of Guam special projects student as an intern.
10. Development of press releases and feature articles and participated in media conferences on various conservation topics.

RECOMMENDATIONS

1. Fill vacant Natural Resource Information and Education Officer position as soon as possible in FY99.
2. Develop and implement a Hunter Education program to compliment the existing PACE program utilizing Division biologists, conservation officers, and community volunteers as instructors.
3. Develop and implement specific public education programs on the brown tree snake and the recovery programs for the Mariana crow, the Micronesian kingfisher, the Guam rail, and other endangered indigenous species. Attempt to develop feelings of cultural pride and concern for the recovery of indigenous wildlife.
4. Develop a teacher-training program for aquatic education.
5. Continue to hold freshwater and marine fishing derbies and clinics for children. In addition, develop a new series of freshwater and marine fishing derbies, clinics, and other events for older youths, ages 13 through 17, and for adults.
6. Explore the possibilities of corporate sponsorship for specific endangered species recovery, conservation, and public awareness programs.
7. Continue aquatic and wildlife presentations at public and private schools, libraries, summer camps, after-school programs, and civic organizations.
8. Develop and implement workshops on various natural resource conservation topics for public and private school teachers.
9. Continue public awareness program through press releases, news articles, press conferences and other media to keep the public informed of the progress and accomplishments of the Division's fish, wildlife and endangered species programs.
10. Update existing and develop new public service announcements for tv and radio.
11. Coordinate the Division's participation in mutual programs and projects with Guam's Department of Education, Guam Coastal Management Program, Sea Grant, the University of Guam Extension Service, Department of Parks and Recreation, the Guam Environmental Protection Agency, the U. S. Fish and Wildlife Service, the U. S. National Park Service, and the Guam National Wildlife Refuge.
12. Develop a traveling exhibit program to present information on the Division's fish and wildlife conservation and management programs and natural resource conservation educational materials in village community centers.

PROGRAM COST: The estimated cost of the project is approximately \$20,000.

This report was prepared by: Robert D. Anderson.

JOB PROJECT REPORT **RESEARCH PROJECT SEGMENT**

STATE: Territory of Guam

PROJECT NO: F-1R-6
SUB-PROJECT NO.: F-1
STUDY: 1
JOB NO.: 1

STUDY 1: Fisheries Participation, Effort, and Harvest Surveys (2430)

JOB 1: Offshore Fisheries Survey

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Monthly offshore fisheries surveys were conducted at the Agana Boat Basin, Agat Marina, and the Merizo Pier from October 1997 through September 1998. The FY98 islandwide offshore catch (Table 1), from primarily small recreational-type vessels, is estimated to be 529.3 metric tons (m.t.). The bulk of the catch, 377.7 m.t., was landed by the trolling method, which consisted primarily of five pelagic species. Bottomfishing produced an estimated 40.3 m.t., primarily snappers, emperors, and groupers, while night-light jigging produced an estimated 31.3 m.t. Spearfishing, both SCUBA spear and snorkel spear, produced 55.5 m.t. of finfish and invertebrates. An additional 24.4 m.t. of finfish were landed by other methods such as gillnet, castnet, jigging, spincasting, aquarium fish collecting, and other rarely encountered methods.

TABLE 1: Composition of the Guam Offshore catch during FY98. Weights are in metric tons (m.t.).

Offshore Fishing Method	FY98 Catch
Trolling	377.7
Bottomfishing	40.3
Spearfishing	55.5
Atulai night-light jigging	31.3
Other Methods	24.4
Total FY97 Offshore Catch	529.3

BACKGROUND

Effective management of the island's offshore fishery resources requires the collection and analysis of data on fishing effort, methods, and harvest. In order to identify trends in fishing participation, effort, and catch, the Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR) has been monitoring offshore fishing activities for the past 21 years. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff, as well as changes in the fishery. Since FY97, the National Marine Fisheries Service (NMFS) and DAWR have been developing and completing a computerized database program to collect and analyze the offshore fisheries data. The expansion program's algorithms are currently being reviewed and verified, and should be completed during FY99. The data in the FY98 report should still

be considered preliminary data. During FY98, historical offshore data since 1989 was entered into the new database system. The statistical basis for the expansion can be found in NOAA SWFC Admin. Reports H-83-21C and H-92-08.

OBJECTIVES

1. To quantify fishing participation, effort, and catch which occurs outside the reef margin in boats.
2. To collect biological data from the specimens examined during interviews.
3. To continue and complete the review and verification of the Guam Offshore Expansion System.

PROCEDURES

During FY98, interviews of returning offshore fishing parties were conducted on four days each month at the Agana Boat Basin (two weekends and two weekdays), two days each month at the Agat Marina (one weekend and one weekday), and two days each month at the Merizo Pier (one weekend and one weekday). Each of these days were randomly selected within weekdays (WD) and weekend/holiday days (WE/H) fields. Agana Boat Basin surveys consist of two periods, from 0500 to 1200 hours and 1600 to 2400. Agat Marina and Merizo Pier survey times differed slightly in the morning survey hours, 0530 to 1200 and 0600 to 1100 hours respectively. Islandwide participation was determined by means of a morning and evening survey, two weekdays and two weekends a month, of all public boat launching areas and accessible makeshift launching sites where all trailers attached to vehicles were counted, but no interviews were taken. The expansion program assumes that a percentage of boats operating out of the Agana Boat Basin, Agat Marina, and the Merizo Pier that are fishing is proportional to the types of fishing occurring on the island as a whole.

Important changes were made in the data expansion process since FY97. These changes include using quarterly rather than monthly expansions in order to account for seasonal fisheries, using the boat log data to calculate participation in the expansion process, expanding data from the three surveyed ports rather than just the Agana Boat Basin, and separating charter and non-charter fishing activity.

RESULTS

Trolling

Five major pelagic species account for 96% of the total troll catch by weight (Table 2). Mahimahi (*Coryphaena hippurus*) made up 29% of the troll catch, followed by bonita (*Katsuwonus pelamis*; 23%), wahoo (*Acanthocybium solandri*; 20%), yellowfin tuna (*Thunnus albacares*; 18%), and Pacific blue marlin (*Makaira mazara*; 6%). Approximately 2% of the remaining troll catch consists of requiem sharks (*Carcharhinidae*), rainbow runner (*Elagatis bipinnulatus*), barracuda (*Sphyraena barracuda*), kawakawa (*Euthynnus affinis*), and other incidental troll catch species. An additional 2% of the troll catch consists of an estimated troll catch. For this part of the troll catch, a species breakdown and measurement of the catch could not be taken due to time constraints imposed by the fishermen. All complete trolling interviews consist of catch, effort and participation information.

TABLE 2: Composition of the Guam troll catch during FY98 by most common species. Weights are in kilograms.

Troll Species	Total Catch	% Total Catch
<i>Coryphaena hippurus</i>	108,773	28.8
<i>Katsuwonus pelamis</i>	86,723	23.0
<i>Acanthocybium solandri</i>	73,908	19.6
<i>Thunnus albacares</i>	69,852	18.5
<i>Makaira mazara</i>	21,263	5.6
"assorted trolling"	6,589	>2
<i>Carcharhinidae</i>	3,478	>1
<i>Sphyrna barracuda</i>	2,793	>1
<i>Euthynnus affinis</i>	1,863	>0.5
<i>Elagatis bipinnulatus</i>	1,015	>0.5
<i>Gymnosarda unicolor</i>	528	>0.5
<i>Tetrapterus angustirostris</i>	405	>0.5
<i>Carangidae</i> species	214	>0.5
Other species	84	>0.5
Total	377,739	100

Trolling participation for all troll trips decreased compared with FY97. The number of trolling boat trips decreased slightly, 7%, 13,836 boat trips from 14,947 boat trips, and the number of people participating in the fishery decreased 17%, 46,296 people compared with 55,810. Each weekday had an average of 9.5 trolling trips per day, while weekends and holidays had an average of 22.6 trips per day, with an overall average of 16.0 trips per day. Approximately 47% of all offshore trips, 13,836 trolling trips out of 29,547 total offshore trips, were trolling trips. Of the trolling trips, 74% were non-charter trips, with each trip averaging 4.0 hours with 4.2 fishermen per trip. Approximately 55% of all troll trips originated from the Agana Boat Basin.

Comparing effort with FY97, the number of hours spent fishing decreased 8%, 57,716 boat hours down from 62,738 boat hours. There were also 231,845 gear-hours and 179,279 person-hours of trolling effort during FY98.

Troll catch increased 6% from FY97, 377.7 m.t. up from 357.4 m.t. Landings decreased 3% for mahimahi (108.8 m.t. from 112.2 m.t.), decreased 16% for bonita (86.7 m.t. from 103.1 m.t.), and decreased 49% for Pacific blue marlin (21.3 m.t. from 41.8 m.t.). Landings for wahoo increased 59% (73.9 m.t. from 46.6 m.t.) and increased 85% for yellowfin tuna (69.9 m.t. from 37.8 m.t.).

Total kilograms of troll fish per hour fished increased 15%, 6.54 kg/hr compared with 5.70 kg/hr in FY97. Comparing between charter and non-charter boats, charter boats had average CPUE's of 4.91 kg/hr and 1.06 kg/gr-hr, while non-charter boats had average CPUE's of 6.95 kg/hr and 1.80 kg/gr-hr. The catch rate for charter boats could have been underestimated by their targeting of marlin during the summer months.

Charter boats account for a significant portion of the overall trolling activity. Although they make up approximately 5% of the trolling fleet, charter boats account for 15% of the catch, 20% of troll fishing hours, 26% of all trolling trips, and 44% of all people participating in trolling. Charter boats caught 11% of wahoo, 42% of Pacific blue marlin, 20% of mahimahi, 5% of yellowfin tuna, and 14% of bonita catch. However, compared with FY97, charter participation, catch, and effort decreased significantly. Charter trips

decreased 32%, troll catch from charter boats decreased 35%, hours fished decreased 28%, and people participating in charter fishing decreased 49%. This was due to a significant drop in Asian tourists during FY98. On the other hand, participation, effort, and catch for primarily recreational fishermen differed. Compared with FY97, the number of primarily recreational troll trips increased 6%, catch increased 19%, hours fished decreased slightly, 1%, with people participating increased 63%.

Bottomfishing

An estimated 40.3 m.t. of bottomfish were landed during FY98, a decrease of 23% from FY97. The bottomfish catch (Table 3) was dominated by four major families: *Lutjanidae* or snappers (20%), *Lethrinidae* or emperors (18%), *Serranidae* or groupers (16%), and *Carangidae* or trevallies and jacks (9%).

TABLE 3: Composition of the Guam bottomfish catch during FY98 by Family* and most common species. Estimated weights are in kilograms (kg).

Family	Total Catch	% Total Catch
<i>Lutjanidae</i> *	7,965	19.7
<i>A. virescens</i>	1,722	21.6+
<i>P. auricilla</i>	1,425	17.9+
<i>L. kasmira</i>	1,266	15.9+
<i>P. flavipinnis</i>	969	12.2+
<i>P. zonatus</i>	609	7.7+
<i>L. bohar</i>	362	4.5+
<i>E. carbunculus</i>	379	4.8+
<i>P. argyrogrammicus</i>	252	3.2+
<i>Lethrinidae</i> *	7,258	18.0
<i>L. rubrioperculatus</i>	2,067	28.5+
<i>M. grandoculus</i>	1,368	18.9+
<i>L. obsoletus</i>	1,119	15.4+
<i>L. olivaceus</i>	359	5.0+
<i>Serranidae</i> *	6,408	15.9
<i>E. fasciatus</i>	3,523	55.0+
<i>E. merra</i>	1,484	23.2+
<i>V. louti</i>	577	9.0+
<i>C. sonneratti</i>	418	6.5+
<i>Carangidae</i> *	3,800	9.4
<i>C. lugubris</i>	1,410	37.1+
<i>C. orthogrammus</i>	1,075	28.3+
<i>C. melampygus</i>	519	13.7+
<i>Balistidae</i> *	2,147	4.8
<i>Holocentridae</i> *	1,746	4.3
<i>Carcharinidae</i> *	1,400	3.5
<i>Mullidae</i> *	1,204	3.0
<i>Hemigaliedae</i> *	1,101	2.7
Other bottomfish species	1,488	3.7
"Assorted bottomfish"***	6,070	15.0
Total	40,341	100.0

*over 1000 kg. +% in respective Family **unable to obtain species breakdown

The dominant bottomfish species caught during FY98 were the black-tipped grouper (*Epinephelus fasciatus*, 3.5 m.t.), the redgilled emperor (*Lethrinus rubrioperculatus*, 2.1 m.t.), the jobfish or uku (*Aprion virescens*, 1.7 m.t.), the honeycomb grouper (*Epinephelus merra*, 1.5 m.t.), the yellowtail kalikali (*Pristipomoides auricilla*, 1.4 m.t.), the black jack (*Caranx lugubris*, 1.4 m.t.), the bigeye emperor (*Monotaxis grandoculus*, 1.4 m.t.), the bluelined snapper (*Lethrinus kasmira*, 1.3 m.t.), the yellowstripe emperor (*Lethrinus obsoletus*, 1.1 m.t.), the yellow-spotted trevally (*Carangoides orthogrammus*, 1.1 m.t.), and opakapaka (*Pristipomoides flavipinnis*, 1.0 m.t.). Compared with FY97, the most significant decreases were seen with the blacksaddle grouper (*E. howlandi*, 4.1 m.t. in FY97 to none observed during FY98), the red-gilled emperor, (decreasing 30%, 2.1 m.t. compared with 2.9 m.t.), the blackspot emperor (*L. harak*, decreasing 74%, 0.68 m.t. compared with 2.7 m.t.), the yellowstripe emperor (*L. obsoletus*, decreasing 73%, 1.1 m.t. compared with 4.1 m.t.), and the lyretail grouper (*Variola louti*, decreasing 42%, 0.58 m.t. compared with 1.0 m.t.). Species with significant increases compared with FY97 were observed with uku, (increasing 38% from 1.3 m.t.), the blue-lined snapper (*L. kasmira*, increasing 217% from 0.6 m.t.), and the black-tipped grouper (*E. fasciatus*, increasing 93% from 1.8 m.t.).

Other important bottomfish include triggerfishes (*Balistidae*, 1.9 m.t.), soldierfishes and squirrelfishes (*Holocentridae*, 1.7 m.t.), requiem sharks (*Carcharhinidae*, 1.4 m.t.), goatfishes (*Mullidae*, 1.2 m.t.), and reef white-tip sharks (*Hemigaliedae*, 1.1 m.t.). For approximately 20% of the bottomfish catch, a species breakdown was not obtained due to time constraints imposed by the fishermen. All complete bottomfish interviews consisted of catch, effort, and participation information.

Comparing bottomfish participation with FY97, the number of bottomfish trips increased 23%, 8,810 trips up from 7,139. Approximately 81% of these trips were from non-charter boats. The number of persons participating in bottomfishing decreased 8%, 36,263 compared with 39,660 in FY97. The number of people participating in bottomfishing was evenly distributed between charter and non-charter bottomfishing. There was an average of 4.71 trips on weekdays and 8.92 on weekends and holidays, with an overall average of 6.81 bottomfish trips per day. Bottomfish trips made up 30% of total offshore trips, each trip averaging 4.02 hours and having 3.90 fishermen.

Comparing bottomfish effort with FY97, the number of boat hours increased 39%, 39,538 boating hours up from 28,469 hours. Approximately 10% of this effort were from charter bottomfishing boats. There were 135,366 bottomfish person-hours and 126,796 bottomfish gear-hours during FY98.

Overall bottomfish catch decreased 21%, 40.3 m.t. down from 52.1 m.t. in FY97. Comparing the four top families, *Lutjanidae* catches increased 12.8%, 7,965 m.t. compared with 7,062 m.t. in FY97), *Lethrinidae* decreased 47.9%, 7,258 m.t. compared with 13,925 m.t. in FY97, *Serranidae* increased 12.8%, 6,408 m.t. compared with 5,682 m.t. in FY97, and *Carangidae* increased 39.7%, 3,800 m.t. compared with 2,720 m.t. in FY97. Comparing the overall catch of most commonly caught bottomfish species between FY98 and FY97, the black-tipped grouper (*E. fasciatus*) increased 92.6% (3,523 m.t. compared with 1,829 m.t.), the red-gilled emperor (*L. rubrioperculatus*) decreased 29.8% (2,067 m.t. compared with 2,943 m.t.), uku (*A. virescens*) increased 37.5% (1,722 m.t. compared with 1,252 m.t.), the honeycombed grouper (*E. fasciatus*) increased 92.6% (3,523 m.t. compared with 1,829 m.t.), the yellowtail kalikali (*P. auricilla*) decreased 10.3% (1,425 m.t. compared with 1,588 m.t.), the blue-lined snapper increased 113.1% (1,266 m.t. compared with 594 m.t.), and the yellowstripe emperor (*L. obsoletus*) decreased 72.6% (1,119 m.t. compared with 4,080 m.t.).

Comparing catch rates, the overall catch rate (kg/hour) decreased 44%, 1.02 kg/hr compared with 1.80 kg/hr in FY97. Bottomfish catch per boat trip decreased 37%, 4.6 kg/boat trip compared with 7.3 kg/boat trip in FY97. Comparing catch rates between charter and non-charter bottomfishing, charter boats had catch rates of 0.92 kg/hr and 0.11 kg/gear-hour, while non-charter fishing had catch rates of 1.03 kg/hr fished and 0.39 kg/gear-hour. The low catch rate for charter boats could be due to the low catch rates of Agat Marina charter boats. These Agat charter boats, which make up 90% of the total bottomfish charter trips, often have upwards five or six trips a day, as many as 25 gear units per trip, and fish in the same area. Their catches consist primarily of low numbers of triggerfish and goatfish, resulting in extremely low catch rates and low catches.

Deep water species comprised 11% of the total bottomfish catch (Table 4). An increase in deep bottomfish was observed compared with FY97, 4.6 m.t. in FY98 compared with 4.0 m.t. Deepwater species encountered consisted primarily of *Etelis*, *Pristipomoides*, and *Carangidae* species. The dominant deepwater bottomfishes were the yellowtail kalikali (*P. auricilla*, 1.4 m.t.), opakapaka (*P. flavipinnis*, 969 kg.) and gindai (*P. zonatus*, 609 kg.).

TABLE 4: Composition of the Guam deep bottomfish catch during FY98. Estimated weights are in kilograms.

Species	Total Catch (kg.)	% Total Deep Bottomfish Catch
<i>Pristipomoides auricilla</i>	1,425	30.8
<i>P. flavipinnis</i>	969	21.0
<i>P. zonatus</i>	609	13.2
<i>P. argyrogrammicus</i>	252	5.5
<i>P. filamentosus</i>	106	2.3
<i>Etelis carbunculus</i>	379	8.2
<i>Seriola dumerili</i>	329	7.1
<i>Aphareus rutilans</i>	318	6.9
Misc. deep bottomfish*	226	4.9
Total	4,613	100.0

*unable to obtain species breakdown

Atulai Night-Light Jigging

Atulai night-light fishing was encountered year round during FY98. This method experienced the most significant increase in participation and catch compared with the other offshore methods. An estimated 31.3 m.t. of fish were landed, a 550% increase from the 5.6 m.t. harvested in FY97 (Table 5). Unlike FY97 where atulai (*Selar crumenophthalmus*) comprised 95% of the night-jigging catch, atulai comprised only 54% of the night-jigging catch. The remainder of the night-jigging catch consisted of sharks (*Carcharinidae*, 8.1 m.t.), dogtooth tuna (*G. unicolor*, 1.9 m.t.), black-spotted stingrays (*Taeniura melanospilos*, 2.1 m.t.), and other species of jacks, snappers, groupers, squirrelfishes, and soldierfishes.

The number of atulai night-light jigging trips increased 413%, 1,655 trips compared with 401 trips during FY97. Effort comprised of 11,587 fishing hours, 29,645 person-hours and 37,976 gear-hours. Each night-jigging trip averaged 18.9 kg, an increase of 40% from FY97. Approximately 52% of all night-jigging trips occurred on weekends and holidays, with 62% of the trips originating from the Agat Marina and Merizo pier. There was an average of 1.1 night-jigging trips per day, 0.7 on weekdays and 1.6 on weekends and

holidays. Each trip averaged 7.0 hours and 2.4 fishermen. Average catch rates were 2.7 kg/hr and 0.8 kg/ gear-hr.

TABLE 5: Composition of the Guam atulai (*Selar crumenophthalmus*) night jigging catch during FY98. Estimated weights are in metric tons.

Species	Total Catch (kg)
<i>Selar crumenophthalmus</i>	16.9
<i>Carcharinidae</i>	8.1
<i>Dasyatidae</i>	2.1
<i>Gymnosarda unicolor</i>	1.9
<i>Sphyrnidae</i>	1.0
Other	1.3
Total Catch (kg)	31.3

Spearfishing

An estimated 55.5 m.t. of speared fish, crustaceans, and mollusks were landed during FY98 (Table 6), an increase of 26% from FY97. The spearfish finfish catch (see Table 7) was dominated by surgeonfishes (*Acanthuridae*, 17.8 m.t.), parrotfishes (*Scaridae*, 11.5 m.t.), groupers (*Serranidae*, 2.8 m.t.), emperors (*Lethrinidae*, 1.8 m.t.), and mullets (*Mullidae*, 1.4 m.t.). The bluespine unicornfish (*Naso unicornis*) was the most important spearfish species taken, comprising 61% of the *Acanthuridae* catch and 19% of the total spearfish catch, followed by the Pacific longnose parrotfish (*Hipposcarus longiceps*, 2.7 m.t.), the yellowband parrotfish (*S. schlegeli*, 1.9 m.t.), and the bullethead parrotfish (*S. sordidus*, 1.4 m.t.). Marine invertebrates, *Trochus niloticus* (1.3 m.t.) and the spiny lobster (*Panilurus penicillatus*, 1.2 m.t.), followed in overall catch. For 19% of the spearfish catches, a species breakdown was not possible due to time constraints imposed by fishermen. For these interviews, an estimated catch weight, as well as participation and effort data, was taken.

TABLE 6: Composition of the Guam spearfish catch during. Weights are in kilograms.

Family/Species*	Total Catch (kg)	% Total Catch
<i>Acanthuridae</i>	17,769	32.0
<i>Naso unicornis</i>	10,775	60.6+
<i>N. lituratus</i>	2,972	16.7+
<i>A. xanthopterus</i>	1,021	5.7+
<i>A. lineatus</i>	1,013	5.7+
<i>N. caesioides</i>	588	5.3+
<i>Scaridae</i>	11,470	20.7
<i>Hipposcarus longiceps</i>	2,715	23.7+
<i>S. schlegeli</i>	1,893	16.5+
<i>S. altipinnis</i>	1,684	14.7+
<i>S. sordidus</i>	1,439	12.5+
<i>S. frontalis</i>	842	7.3+
<i>S. microrhinos</i>	746	6.5+
<i>S. rubroviolaceus</i>	519	4.5+
<i>Trochus niloticus</i>	1,318	2.4
<i>Kyphosidae</i>	1,297	2.3
<i>K. cinerascens</i>	984	75.9+
<i>Palinurinae</i>	1,426	2.6

<i>Panulirus penicillatus</i>	1,155	81.0+
<i>Lethrinidae</i>	1,796	3.2
<i>L. harak</i>	615	34.2+
<i>Serranidae</i>	2,815	5.1
<i>Epinephelus lanceolatus</i>	1,010	35.9+
<i>Mullidae</i>	1,364	2.5
<i>Siganidae</i>	1,331	2.4
<i>S. punctatus</i>	679	51.0
<i>Lutjanidae</i>	1,211	2.2
<i>Diodontidae</i>	799	1.4
<i>Diodon hystrix</i>	779	97.5+
<i>Labridae</i>	1,187	2.1
<i>Cheilinus undulatus</i>	736	62.0+
<i>Carangidae</i>	763	1.4
<i>Holocentridae</i>	595	1.1
<i>Octopus</i> sp.	539	1.0
Assorted Reef Fish**	10,323	18.6
Total	55,527	100.0

*Family and Species over 500 kg. +% in respective Family. **unable to obtain species breakdown.

Spearfishing participation increased during FY98. There was a 68% increase in the number of spearfishing trips compared with FY97, 3,515 trips versus 2,091 trips, and a 22% increase in the number of people participating in this fishery, 10,054 people compared with 8,216 in FY97. Effort increased 74%, up 9,409 boat hours from 5,399 boat hours in FY97. Total spearfish catch increased 26%, 55.5 metric tons compared with 44.2 metric tons in FY98.

Snorkel spearfishing accounted for 2,610 trips, 74% of all spearfishing trips, harvesting a total of 21.9 m.t. (Table 7). Snorkel spearfishing averaged 0.8 trips a day, with each trip averaging 1.3 hours and 3.8 fishermen, and had an average catch of 1.25 kg/gear-hour. Compared with FY97, the catch rate for each trip decreased 43%, from 14.8 kg/trip in FY97 to 8.4 kg/trip. In terms of effort, snorkel spearfishing had a total of 7,750 hours, 6,737 persons in the fishery, and 17,455 gear hours. The most common species caught by this method were the orangespine unicornfish (*Naso lituratus*, 2.2 m.t.), the bluespine unicornfish (1.9 m.t.), the Pacific longnose parrotfish (1.2 m.t.), the tan-faced parrotfish (*S. frontalis*, 0.8 m.t.).

TABLE 7: Comparison of Participation and Catch between Snorkel spearfishing and SCUBA spearfishing during FY98.

Spearfishing Method	Number of trips	Catch metric tons (mt)	Catch per trip (kg/trip)	Catch per gear hour (kg/gh)
Snorkel Spear	2,610	21.9	8.37	1.25
SCUBA Spear	905	33.7	37.21	7.20
Total	3,515	55.5		

SCUBA spearfishing accounted for 905 trips, approximately 27% of all spearfishing trips, with a harvest of 33.7 m.t., or 61% of all spearfishing catch (Table 7). SCUBA spearfishing averaged 0.7 trips per day, with each trip averaging 4.3 hours and 2.5 fishermen, and had an average catch of 7.2 kg/gear-hour. Compared with FY97, the catch rate for each trip increased slightly, 37.2 kg/ trip up from 36.2 kg/trip. In terms of effort, SCUBA spearfishing had a total of 1,659 hours, 6,187 person-hours, and 4,678 gear-hours. The most common species caught by this method were the bluespine unicornfish

(8.8 m.t.), the Pacific longnose parrotfish (1.5 m.t.), trochus (1.3 m.t.), the filament-finned parrotfish (*S. altipinnis*, 1.4 m.t.), the yellowband parrotfish (1.1 m.t.), and the giant grouper (*Epinephelus lanceolatus*, 1.0 m.t.).

Other Methods

Other less common fishing methods encountered during the offshore surveys accounted for 24.4 m.t. of finfish, less than 5% of the total offshore catch. This category experienced a thirteen-fold increase in finfish catch between FY96 and FY97, but decreased 22% between FY97 and FY98. The most common methods in this category were gillnetting (14.0 m.t.), castnetting (1.9 m.t.), jigging (1.1 m.t.), and spincasting (1.0 m.t.), and other rarely encountered methods. Fish species dominating these methods were atulai caught using gillnets (12.0 m.t.), the bluespot mullet (*Valamugil seheli*, 1.1 m.t.), octopus (1.9 m.t.), and the convict tang (*Acanthurus triostegus*, 0.8 m.t.),

DISCUSSION

The total offshore catch for FY98 increased slightly compared with FY97, less than 8%. An increase in catch was observed with trolling (6%), atulai night-light jigging (550%), and spearfishing (26%), while a decrease in catch was observed with bottomfishing (21%) and other boat-based methods (22%). Increased catch rates were observed with atulai night-light jigging (40%), SCUBA spearfishing (3%) and trolling (15%), while decreased catch rates were observed with bottomfishing (44%) and snorkel spearfishing (43%). The decrease in catch rates for bottomfishing and spearfishing, combined with an increase in their participation and effort could reflect an over-utilized limited marine resource. Since FY94, except for FY95 when offshore data was not expanded, catch rates for bottomfishing, total spearfishing, and snorkel spearfishing have been decreasing. This trend could seriously impact many of the species important in nearshore fisheries, especially if other methods impacting shallower areas, such as gillnetting, and the continued increase in SCUBA spearfishing continue unrestricted.

Participation and effort in SCUBA spearfishing has been steadily increasing. Participation and effort for this method may be underestimated since several unsurveyed ports, especially Ylig River, are important launch sites for SCUBA spearfishing. The east side of Guam, while inaccessible to most boats during most of the year, is fished heavily during periods of calm weather. Therefore, spearfishing catches may be underestimated. For the past several years, the increase in SCUBA spearfishing activity was due to a small core of commercial spearfishermen concentrating their efforts in waters over 30 meters deep, fishing primarily at night. During FY98, these spearfishermen have been reported to dive in waters as deep as 50 meters, use state-of-the-art diving computers, and perform multi-tank dives as often as three times a week, weather permitting. Continued unrestricted use of this method can potentially become a serious threat to many reef species, especially diurnal herbivores such as parrotfishes, unicornfishes, and surgeonfishes. Since these fish sleep at night and occur in the diving range of SCUBA spearfishermen, an increase in effort could seriously deplete these species, especially large individuals. Compared with FY97, the most important spearfishing species, the bluespine unicornfish (*Naso unicornis*), and the most important Family, *Acanthuridae*, have experienced a decrease in catch of 35% and 10%, respectively.

The decrease in the overall harvest and catch per unit of effort for bottomfishing during FY98 seems to also reflect an over-utilized nearshore and shallow water fishery. The most significant drop was observed with species of *Lethrinidae*, which contain several of the most important bottomfish species on Guam. This fishery has been experiencing a decrease in catch rate (kg/hour fished) since FY94, with several important species (*L.*

rubrioperculatus and *V. louti*) showing a decrease in overall catch. Continued increases in participation and effort could result in a further lowering of overall catch and catch rates for bottomfishing.

Charter boat activity comprises a significant portion of the trolling activity. Since the end of FY97, however, a significant decrease in the number of charter trolling trips per day was observed throughout FY98. This was due to a drastic drop in the number of tourists, related to the current Asian economic crisis, resting in a significant drop in charter boat activity (32%) and charter boat catch (35%) during FY98. Since charter boats target marlin during the summer months, this could account for the decrease in marlin catch during FY98.

A major deficiency with comparing FY98 CPUE with previous years is the lack of one consistent measure of CPUE. During FY97, the only measure of CPUE available was kilograms of catch per boat trip. While this measurement of CPUE was also available for FY98 to compare with FY97, other appropriate measures of CPUE were also used in the FY98 report.

RECOMMENDATIONS

The new survey design and computerized database analyzing the offshore data is currently being completed, with the assistance of NMFS. The new offshore expansion program is designed to provide a standard methodology for analyzing and comparing historical offshore data in order to obtain a more reliable history of the various offshore fisheries on Guam. This is especially important with bottomfishing and spearfishing, since these fisheries are heavily impacted by exclusively local fishing pressure. It is recommended to continue working with NMFS on completing the offshore expansion program and continue entering historical data into the system for re-expansion and analysis.

Separate studies on fishing pressures by particular methods, fishing pressures on specific areas, and the on the biology and effects on recreationally important fishes are also recommended. The decrease in the overall catch and catch rates of bottomfishing and spearfishing, and continued unrestricted fishing pressure by methods such as SCUBA spearfishing and gillnetting is a cause for concern. While there are other factors that contribute to the decline in reef fish catch, data resulting from these studies should provide a clearer picture on the contribution of unrestricted fishing pressures on local fish stocks. Based on recent trends, appropriate management schemes should be implemented in the near future to halt further depletion of recreationally important fishes.

PROGRAM COSTS

The estimated cost of the project is \$202,000.

Report was prepared by: Thomas Flores, Jr.

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-6
SUB-PROJECT NO.: F-1
STUDY NO.: 1
JOB NO.: 2

STUDY: Fisheries Participation, Effort, and Harvest Surveys (2430)

JOB TITLE: Inshore Fisheries Survey

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Monthly inshore fisheries surveys were conducted along Guam's shoreline from October 1997 through September 1998. The total estimated inshore fisheries catch for this time period was 49.5 mt (metric tonnes), 88% of which were finfish (excluding the juvenile rabbitfish or mañâhak and juvenile fusilier or achemsom). Hook and line was the most practiced method accounting for 57% of the total participation (excludes seasonal mañâhak and atulai data) or 42,330 participants. In terms of catch rate, snorkel spearfishing was the most successful of all the daytime methods, yielding approximately 2.41 kg/gear-hour (gh) with a daytime harvest of 5.6 mt, and drag net was the most successful nighttime fishing method, yielding approximately 10.18 kg/gh with a nighttime harvest of 0.26 mt. Hook and line was the most successful method in terms of the overall harvest, yielding approximately 0.22 kg/gh with a total harvest of 17.4 mt. The seasonal mañâhak and achemsom catch was not surveyed in FY98.

Aerial Survey

The aerial survey report is included in Appendix 1.

Kid's Fishing Derby

The Kid's Fishing Derby report is included in Appendix 2.

BACKGROUND

Effective management of Guam's inshore fishery resources requires accumulating data on the types of fishing methods used, fishing pressure, and annual catch. To identify trends in fishing participation, effort, and catch, the Division of Aquatics and Wildlife Resources (DAWR) has been monitoring marine fishing activities since the early 1960's. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. In the last several years, however, field survey techniques have been expanded and refined, while estimates of Guam's recreational / subsistence fishing activities have come to be based on more reliable data analysis techniques.

Data Analysis

The adoption of the 4th Dimension (4D) database program has greatly reduced the time needed to compile and analyze Guam's inshore survey data. This has allowed more time to upgrade data collection procedures and to ensure statistical reliability.

OBJECTIVES

- 1) To establish baseline catch and effort data for reef fish species necessary to develop a fisheries management plan for Guam.
- 2) To gather limited biological data on Guam's fisheries for management purposes.

PROCEDURES

During FY98, four "inshore-catch" survey days were selected per month. Fishermen-intercept interviews were conducted to determine amount of effort, fishing method, location, reef zone, species composition, and amount caught for both day and night fishing. The day survey covered a six-hour interval (beginning at 0630h) and the night survey covered a five-hour interval (beginning at dusk or 1900h). On any given survey day, one survey area (Figure 1), is randomly selected from either Gun Beach to Adelupe (region I: locations 1-11), Adelupe to Agat (region II: locations 12-34), or Pago to Merizo (region III: locations 71-41) and inshore data collection is restricted within the selected region. However, because of infrequently interviewed methods, e.g., surround netting, and low participation, representative samples can be difficult to obtain. Therefore, if this situation occurred, one or both of the other two adjacent areas could be surveyed.

During FY98, day and night "inshore-participation" surveys were conducted on four randomly selected days per month, which did not occur on the same days as the "inshore creel" surveys. These surveys entailed making visual observations of fishing participation within readily accessible portions of Guam's coastline (Fig. 1, locations: 1-21, 23-26, 29-35, 40-43, 51-57, 60-69, 71, 72). Fishing catch and effort data is collected by instantaneous counts, while driving in a continuous route, around the island. The route is alternated each survey between "clockwise" and "counterclockwise" and the starting locations are randomly selected (Fig. 1). Since the participation survey includes both day and night fishing, start times begin at 0630h and 1900h and end once the entire island circuit has been completed.

Seasonal data on the scad mackerel (atulai), goatfish (ti'ao), and jacks (i'e') were acquired through actual participation and catch surveys. Species of fish that seasonally recruit *en masse* on Guam's reefs, i.e., juveniles of rabbitfish (mañâhak), and fusiliers (achemsom) were not entered into the database due to the sporadic nature of these fisheries.

Mañâhak *en masse* recruitment events are predicted to occur up to three times a year for approximately one-week, depending on the overall size of the run. Recruitment events are expected to begin the day of or days following the fourth, fifth, and tenth last quarter moon phase. Recruitments of achemsom are irregular, but have been significant in terms of island-wide total harvest in certain years and usually recruit with mañâhak when they occur.

Atulai migrate into inshore areas throughout the year, which may cover a period lasting up to nine months. They usually enter protected locations, e.g., bays and channels, at daybreak and swim into deeper water before evening. A significant portion of the annual

catch is not reported from this fishery because the larger net catches are sporadic and seldom appear on regular surveys.



Figure 1. Inshore Fisheries "Participation Survey" Route with Area and Location Codes.

Ti'ao and i'e' recruit annually on reef flats and make up a large portion of the annual catch and effort. Ti'ao generally recruit within a few days of the May full moon and during strong recruitment years, pulses of new recruits will also follow the June and July full moons. I'e' runs also follow the full moon starting in May and can continue after each full moon through November. It is speculated that continued recruitment may be linked to rainfall. Past recruitment events of these species have shown to be highly significant in terms of total catch, especially *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* with hook and line, and *Mulloides flavolineatus* and *M. vanicolensis* with nets, when they occur.

The FY98 inshore harvest estimates were statistically expanded by a computer software package for Macintosh known as the Fourth Dimension (4D) database program. The 4D program utilizes formulae described in the FY83 report (Project FW-2R-20, Sub-Project F, Study F-1, Job 2) to compile and expand inshore survey data for the fiscal year.

RESULTS

During FY98, the estimated inshore harvest for day, night, and seasonal fishing around Guam was 49.5 mt. Finfish accounted for 88% of total harvest or 43.7 mt. The seasonal mañahak and achemsom harvests were marginal and not recorded in FY98. The total inshore catch (finfish and invertebrates) resulted from a total effort of 260,497 person-hours (ph) and 210,131 gear-hours (gh). Overall, approximately 0.24 kg/gh of fish were harvested with 137 daytime and 176 nighttime species identified in FY98.

CATCH

Hook and line fishing yielded the largest overall catch with 17.3 mt or 40% of the total finfish harvest. Snorkel spearfishing was second with 11.3 mt or 26%, while gill netting was third with 8.5 mt or 19%, and cast netting was fourth with 5.9 mt or 13% of the total finfish harvest (Table 1).

Table 1. Combined estimated inshore participation, effort, and total harvest (kg) for all methods during the day and night in FY98.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	42,330	41,206	24,258	145,056	141,611	17,373	17,294	79	0.22 wd
Cast Net	8,717	7,908	7,122	19,469	17,605	5,852	5,852	0	1.35 wn
Gill Net	14,421	5,755	2,840	73,809	29,649	8,789	8,478	311	0.39 wen
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	4,804	4,580	2,452	10,752	10,275	13,460	11,295	2,165	2.41 wd
Spear SCUBA	127	127	58	247	247	299	295	4	1.28 wn
Drag Net	337	49	49	523	80	288	282	6	10.18 wen
Hooks & Gaffs	1,085	1,099	759	2,066	2,088	1,292	126	1,166	1.16 wd
Other††	3,002	3,002	2,216	8,576	8,576	2,158	70	2,088	1.04 wd
TOTAL	74,824	63,730	39,759	260,497	210,131	49,511	43,692	5,819	0.24

†CPUE summary derives the greatest weekday (wd), weeknight (wn), weekend day (wed), or weekend night (wen) from Tables 2 and 3. The greatest CPUE value for hook and line was in regions 1 and 2.

††Other Methods usually includes: gleaning, hand nets, traps, and spears.

The top three daytime methods accounted for approximately 84% of the daytime total and 58% of the combined total harvest (Table 2). Hook and line fishing accounted for the most fish with 14.1 mt or 47% of the day finfish harvest. Gill netting was second with 5.6 mt or 19%, while cast netting was third with 5.5 mt or 18%, and snorkel spearfishing was fourth with 4.7 mt or 16% of the total day finfish harvest.

The top three nighttime methods accounted for approximately 93% of the night total and 29% of the combined total finfish harvest (Table 3). Snorkel spearfishing accounted for the most fish caught with 6.6 mt or 49% of the total night finfish harvest and hook and line fishing was second with 3.2 mt or 24%. Gill netting was third with 2.9 mt or 21% and cast netting was fourth with 0.3 mt or 2% of the total night finfish harvest.

EFFORT

Hook and line fishing was the most practiced fishing method overall (Table 1), accounting for 42,330 persons or approximately 57% of total participation. Gill netting was the second most practiced method overall, accounting for 14,421 participants or 19%, while cast netting followed in third with 8,717 participants or 12% of the total participation.

The rank order for day fishing participation placed hook and line first with 29,287 or 56% participants. Gill netting and cast netting placed second and third respectively with 9,946 or 19% and 8,440 or 16% of the participants (Table 2). Hook and line fishing remained the most practiced night fishing method with 13,044 participants or 59% of night participation. The second most practiced method was gill netting with 4,475 participants or 20%, while snorkel spearfishing followed in third with 3,065 participants or 14% of night participation (Table 3).

CATCH PER UNIT EFFORT (CPUE)

Snorkel spearfishing had the highest daytime CPUE of 2.41 kg/gh for weekday fishing and drag netting followed in second with 2.11 kg/gh and hook and gaffs were third with 1.16 kg/gh (Tables 1 and 2). Drag netting had the highest nighttime CPUE of 10.18 kg/gh for weekend night fishing, cast netting followed in second with 1.35 kg/gh, and SCUBA spearfishing was in third with 1.28 kg/gh (Tables 1 and 3).

Summary information concerning effort and harvest for methods not discussed are included in Tables 1-3. Other nearshore fisheries harvests on Guam, including spear and net fishing off berthed and boats with trailers, were recorded in the FY98 Offshore Fisheries Report (Study F-1, Job 1).

Table 2. Estimated inshore participation, effort, and total harvest (kg) for all methods during the day in FY98.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	29,287	28,466	18,489	100,9339	98,285	14,098	14,057	41	0.22 wd
Cast Net	8,440	7,721	6,964	18,847	17,200	5,548	5,548	0	0.34 wd
Gill Net	9,946	4,095	2,004	48,654	20,045	5,787	5,570	217	0.31 wd
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	1,739	1,529	1,074	3,613	3,171	5,612	4,651	961	2.41 wd
Spear Scuba	0	0	0	0	0	0	0	0	0.0
Drag Net	21	11	11	26	13	28	28	0	2.11 wed
Hooks & Gaffs	1,085	1,098	759	2,066	2,088	1,292	126	1,166	1.16 wd
Other††	2,211	2,211	1,851	2,193	2,193	1,459	18	1,441	1.04 wd
TOTAL	52,728	45,130	31,151	176,330	142,994	33,824	29,998	3,826	0.24

†CPUE summary derives the greatest weekday (wd) and weekend day (wed) values. The greatest CPUE value for hook and line was in regions 1 and 2.

††Other Methods usually includes: gleaning, hand nets, traps, and spears.

Table 3. Estimated inshore participation, effort, and total harvest (kg) for all methods during the night in FY98.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	13,044	12,740	5,769	44,123	43,326	3,275	3,237	38	0.19 wn
Cast Net	278	187	158	622	406	304	304	0	1.35 wn
Gill Net	4,475	1,659	836	25,155	9,604	3,002	2,908	94	0.39 wen
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	3,065	3,052	1,379	7,139	7,104	7,849	6,645	1,204	1.26 wen
Spear SCUBA	127	127	58	247	247	299	295	4	1.28 wn
Drag Net	316	43	43	496	67	260	254	6	10.18 wen
Hooks & Gaffs	0	0	0	0	0	0	0	0	0.0
Other††	791	791	365	6,384	6,384	700	53	647	0.11 wn/wen
TOTAL	22,096	18,600	8,607	84,167	67,138	15,688	13,695	1,993	0.23

†CPUE summary derives the greatest weeknight (wn) and weekend night (wen) values. The greatest CPUE value for hook and line was in region 3.

††Other Methods usually includes: gleaning, hand nets, traps, and spears.

Species and Family Harvests

The expanded species composition for the combined day and night efforts were calculated for FY98. The top non-seasonal reef fish species caught was the bluespine unicornfish, *Naso unicornis*, with 4.0 mt or 9.18% of the finfish total and the scad mackerel, *Selar crumenophthalmus* was the top seasonal and overall species caught with 4.1 mt or 9.38% of the finfish total. Acanthuridae was the top family of finfish harvested with 8.9 mt or 20.39% of the combined harvest in FY98 (Table 4).

Table 4. FY98 combined day and night catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200mm), *Mulloides flavolineatus* (ti'ao ≤ 100mm), and *Siganus spinus* (mañāhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day and night catch (43,692 kg).

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
<i>Selar crumenophthalmus</i>	4,097.78	9.38	Acanthuridae	8,909.06	20.39
<i>Naso unicornis</i>	4,011.65	9.18	Carangidae	8,834.29	20.22
<i>Kyphosus vaigiensis</i>	3,310.49	7.58	Kyphosidae	3,489.13	7.99
<i>Siganus spinus</i>	2,257.04	5.17	Siganidae	2,625.54	6.01
<i>Caranx i'e'</i>	2,148.65	4.92	Mugilidae	2,486.94	5.69
<i>Acanthurus triostegus</i>	2,021.09	4.63	Mullidae	2,444.55	5.59
<i>Valamugil engeli</i>	1,584.85	3.63	Lethrinidae	2,379.98	5.45
<i>Mulloides flavolineatus</i>	1,495.49	3.42	Scaridae	2,276.89	5.21
<i>Lethrinus harak</i>	980.64	2.24	Holocentridae	1,954.76	4.47
<i>Naso lituratus</i>	841.91	1.93	Lutjanidae	1,811.95	4.15
TOTAL ANNUAL COMBINED CATCH	22,749.59	52.07		37,213.09	85.17

The top daytime species caught was *Kyphosus vaigiensis*, accounting for 3.1 mt or 10.47% and *Selar crumenophthalmus* was ranked first overall and seasonal, with 3.6 mt or 11.92% of the day total. Carangidae ranked first with 7.5 mt or 25.05% for the top family day harvest, representing two seasonal species in the top five for FY98 (Table 5).

Table 5. FY98 day catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' $\leq$ 200mm), *Mulloides flavolineatus* (ti'ao $\leq$ 100mm), and *Siganus spinus* (mañâhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day catch (29,998 kg).

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
<i>Selar crumenophthalmus</i>	3,575.30	11.92	Carangidae	7,514.20	25.05
<i>Kyphosus vaigiensis</i>	3,140.68	10.47	Acanthuridae	5,577.64	18.59
<i>Naso unicornis</i>	2,993.33	9.98	Kyphosidae	3,260.38	10.87
<i>Siganus spinus</i>	1,885.62	6.29	Siganidae	2,034.92	6.78
<i>Caranx i'e'</i>	1,678.01	5.59	Lethrinidae	1,774.68	5.92
<i>Acanthurus triostegus</i>	1,539.72	5.13	Mugilidae	1,725.05	5.75
<i>Valamugil engeli</i>	1,209.61	4.03	Mullidae	1,420.54	4.74
<i>Clarias batrachus</i>	824.62	2.75	Scaridae	1,417.59	4.73
<i>Mulloides flavolineatus</i>	805.22	2.68	Lutjanidae	943.87	3.15
<i>Caranx papuensis</i>	780.36	2.60	Clariidae	824.62	2.75
TOTAL ANNUAL DAY CATCH	18,432.47	61.45		26,493.49	88.32

Naso unicornis topped the night harvest with 1.0 mt or 7.44% of the night total. *Selar crumenophthalmus* and *Caranx i'e'* ranked sixth and eighth respectively for night seasonal species harvest in FY98. Acanthuridae was harvested over two times greater than any other family, with 3.3 mt or 24.33% of the top family with four species making the top ten night harvest list (Table 6).

Method Harvests

The top harvest of finfish species for hook and line method was calculated for FY98 (Table 7). *Naso unicornis* was the top ranked species, with 1.7 mt (8.57%) for day, while *Selar crumenophthalmus* ranked first for seasonal, with 3.6 mt for day (25.37%) and 0.5 mt (15.93%) for night and *Caranx i'e'* ranked in second for seasonal at night, with 0.3 mt (9.51%).

The top harvest of finfish species for gill net method was calculated for FY98 (Table 8). *Valamugil engeli* ranked first for day with 0.8 mt (14.34%) of the daytime harvest and *Mulloides flavolineatus* ranked first at night, with 0.2 mt (19.0%). Seasonal species did not rank in the top ten for gill net, but *Caranx i'e'* ranked eighth for night, with 0.1 mt (5.19%).

The top harvest of finfish species for snorkel spear method was calculated for FY98 (Table 9). *Kyphosus vaigiensis* ranked first during the day, with 2.1 mt (46.17%), while *Naso unicornis* ranked first at night, with 0.9 mt (13.29%) of the snorkel spear harvest. Seasonal species did not make the top ten rankings for snorkel spear in FY98.

Table 6. FY98 night catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' $\leq$ 200mm), *Mulloides flavolineatus* (ti'ao $\leq$ 100mm), and *Siganus spinus* (mañāhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total night catch (13,695 kg).

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
<i>Naso unicornis</i>	1,018.32	7.44	Acanthuridae	3,331.42	24.33
<i>Naso lituratus</i>	732.17	5.35	Holocentridae	1,557.39	11.37
<i>Mulloides flavolineatus</i>	690.27	5.04	Carangidae	1,320.09	9.64
<i>Acanthurus lineatus</i>	652.77	4.77	Mullidae	1,024.01	7.48
<i>Myripristis murdjan</i>	586.22	4.28	Lutjanidae	868.08	6.34
<i>Selar crumenophthalmus</i>	522.48	3.82	Scaridae	859.30	6.27
<i>Acanthurus triostegus</i>	481.37	3.51	Mugilidae	761.89	5.56
<i>Caranx i'e'</i>	470.64	3.44	Lethrinidae	605.30	4.42
<i>Valamugil engeli</i>	375.24	2.74	Siganidae	590.62	4.31
<i>Siganus spinus</i>	371.42	2.71	Serranidae	441.30	3.22
TOTAL ANNUAL NIGHT CATCH	5,900.90	43.09		11,359.40	82.95

Table 7. FY98 day and night catch for the top ten species of finfish harvested by hook and line method. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' $\leq$ 200mm) are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day (14,057 kg) and night (3,237 kg) hook and line catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
<i>Selar crumenophthalmus</i>	3,566.11	25.37	<i>Selar crumenophthalmus</i>	515.77	15.93
<i>Naso unicornis</i>	1,695.33	8.57	<i>Caranx i'e'</i>	334.68	9.51
<i>Caranx i'e'</i>	1,302.69	6.59	<i>Lutjanus monostigmus</i>	331.75	9.43
<i>Clarias batrachus</i>	824.62	4.17	<i>Lutjanus fulvus</i>	220.45	6.27
<i>Caranx melampygous</i>	728.44	3.68	<i>Kyphosus vaigiensis</i>	168.95	4.80
<i>Caranx papuensis</i>	660.49	3.34	<i>Lethrinus harak</i>	165.85	4.71
<i>Lethrinus harak</i>	625.12	3.16	<i>Lethrinus xanthochilus</i>	139.18	3.96
<i>Lethrinus olivaceus</i>	465.76	2.36	<i>Epinephelus merra</i>	137.30	3.90
<i>Kyphosus vaigiensis</i>	395.72	2.00	<i>Caranx ignobilis</i>	97.77	2.78
<i>Naso tuberosus</i>	382.50	1.93	<i>Cephalopholis argus</i>	71.18	2.02
Total Top Ten Hook & Line Catch	10,646.78	61.17		2,182.88	63.32
Total Combined Hook & Line Catch	12,829.66				

Table 8. FY98 day and night catch for the top ten species of finfish harvested by gill net method. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' $\leq$ 200mm), *Mulloides flavolineatus* (ti'ao $\leq$ 100mm), and *Siganus spinus* (mañāhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day (5,570 kg) and night (2,908 kg) gill net catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
<i>Valamugil engeli</i>	798.75	14.34	<i>Mulloides flavolineatus</i>	552.49	19.00
<i>Mulloides flavolineatus</i>	700.87	6.49	<i>Valamugil engeli</i>	349.13	16.15
<i>Acanthurus triostegus</i>	507.97	4.70	<i>Acanthurus triostegus</i>	202.95	9.39
<i>Scarus sordidus</i>	392.19	3.63	<i>Valamugil seheli</i>	194.17	8.98
<i>Neoniphon sammara</i>	324.66	3.00	<i>Liza vaigiensis</i>	117.61	5.44
<i>Carcharhinus melanopterus</i>	228.23	2.11	<i>Leiognathus equulus</i>	115.46	5.34
<i>Siganus spinus</i>	182.22	1.69	<i>Caranx i'e'</i>	112.28	5.19
<i>Gerres acinaces</i>	155.77	1.44	<i>Hymantura granulata</i>	107.67	4.98
<i>Scolopsis lineatus</i>	125.63	1.16	<i>Gerres acinaces</i>	74.85	3.46
<i>Balistoides viridescens</i>	124.49	1.15	<i>Caranx sexfasciatus</i>	70.43	3.26
Total Top Ten Gill Net Catch	3,540.78	39.72		1,897.04	81.19
Total Combined Gill Net Catch	5,437.82				

Table 9. FY98 day and night catch composition for the top ten species of finfish harvested by snorkel spear method. Finfish harvest percentages were derived from the total day (4,651 kg) and night (6,645 kg) snorkel spear catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
<i>Kyphosus vaigiensis</i>	2,147.49	46.17	<i>Naso unicornis</i>	882.84	13.29
<i>Naso unicornis</i>	1,298.00	15.25	<i>Naso lituratus</i>	652.46	7.17
<i>Trachinotus blochii</i>	421.50	4.95	<i>Acanthurus lineatus</i>	646.46	7.11
<i>Scarus frontalis</i>	369.62	4.34	<i>Myripristis murdjan</i>	544.19	5.98
<i>Scarus microrrhinos</i>	188.05	2.21	<i>Cheilinus trilobatus</i>	260.40	2.86
<i>Siganus spinus</i>	97.59	1.15	<i>Acanthurus triostegus</i>	215.28	2.37
<i>Lutjanus argentimaculatus</i>	31.88	0.37	<i>Sargocentron tiere</i>	202.14	2.22
<i>Lethrinus harak</i>	25.72	0.30	<i>Siganus spinus</i>	201.58	2.22
<i>Naso lituratus</i>	25.51	0.30	<i>Scarus psittacus</i>	184.78	2.03
<i>Liza vaigiensis</i>	23.13	0.27	<i>Myripristis violacea</i>	174.82	1.92
Total Top Ten Spear Snorkel Catch	4,628.49	75.31		3,964.95	47.17
Total Combined Spear Snorkel Catch	8,593.44				

Seasonal Harvests

The seasonal catch of certain juvenile fishes is widely anticipated by local fishermen. The FY98 harvests of i'e' and ti'ao were well represented within the expansion estimates

(Tables 4 - 6), especially *Caranx i'e'*. During FY98, small pulses of recruiting ti'ao occurred in November and July and i'e' occurred from March - September. I'e' (*Caranx* spp.) ranked fifth for overall and daytime harvests (Tables 4 and 5) and ranked eighth for the night harvest (Table 6) in FY98.

FY98 marked a below average recruitment year for mañāhak (ha'tang or *Siganus spinus* and lessō' or *S. argenteus*). Small runs occurred in early June and the middle of September in FY98. As of June 1997, DAWR suspended the collection of mañāhak harvest data, because this information was not critical to management of the reef fishery.

The atulai (*Selar crumenophthalmus*) season was successful during the last few months in FY98, but did not reflect this during the creel surveys with 4.1 mt or 9% of the total catch for FY98. The total inshore harvest of atulai (99.7% of day and night harvest) were caught with hook and line, due to the high incidence of catch interviews at the Agana Boat Basin channel (Fig. 1, location 9 and Table 7).

In addition to finfish, a significant number of marine invertebrates were harvested from Guam's reefs. An estimated 2.8 mt of octopus, e.g., *Octopus cyanea* and *O. ornatus*, which made up approximately 49% of the total invertebrates harvested, were caught island-wide in FY98. Daytime octopus harvests accounted for 2.2 mt (53% by hooks and gaffs, 42% by snorkel spear, and 5% by other methods), while nighttime harvests accounted for 0.6 mt (90% by snorkel spear, 8% by other methods, and 2% by gill nets) in FY98.

The mangrove crab, *Scylla serrata*, was the second-most harvested with a day and night island-wide harvest of 0.9 mt (78% by crab trap, 17% by gill net, and 5% by hook and line) in FY98. The third most caught invertebrate was spiny lobster, *Panulirus penicillatus*, with an estimated 0.4 mt (79% by snorkel spear and 21% by gill nets) in FY98. Harvests of reef crustaceans and molluscs accounted for an estimated 1.6 mt and 0.2 mt respectively, in FY98.

Other methods, e.g., gleaning, crab trapping, and hand netting, produced an estimated 2.2 mt of finfish and invertebrates, e.g., *Arothron* and *Toxopneustes*, with a catch rate of 0.25 kg/ph of fishing effort.

Harvests were not representative of the actual participation, due to the rarity of certain methods within the "inshore-catch" survey window (especially nighttime for certain methods), and includes the following methods for day: surround net, spear SCUBA, hook and gaffs, and drag net; and for night: cast net, surround net, hooks and gaffs, and drag net. Methods encountered more frequently, i.e., hook and line, cast net (day only), gill net, spear snorkel, spear SCUBA (night only, and other methods, had expansion confidence intervals less than 31% for daytime and less than 33% for nighttime fishing activity.

Fishable Index Hours (FIH)

The FIH default is a parameter used in the expansion to identify the amount of time a person can fish with a particular method during a survey day. Windows of survey fishable time included: the a.m. (0600-1200 hours), p.m. (1900-2400 h), whole day (0600-1800 h), and whole night (1900-0200 h). The FIH is determined by dividing the survey fishable time by the whole day fishable time for each method. Fishable hours for each method are determined by the state of the tide. Some methods are not restricted by tide, e.g. hook and line and spearfishing. Net fishing and is limited to tides above 0.5 ft.,

while hooks and gaffs for octopus and other methods are limited to tides below 0.5 ft (Table 10).

Table 10. Fishable Index Hours (FIH). Methods are listed as follows: Hook and Line (HL); Cast, Gill, Surround, and Drag Nets (N); Snorkel and SCUBA spear (SP); Hooks and Gaffs (HG); and Other Methods (OM), are listed for day and nighttime values for FY98.

**Daytime FIH Values for
FY98**

Method	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sep
Nets	2.40	2.48	2.20	2.20	2.20	2.15	1.90	1.80	1.80	1.73	1.89	2.34
HG	1.00	1.00	1.00	1.00	1.00	1.25	2.50	3.00	4.00	4.00	2.38	2.38

**Nighttime FIH Values
for FY98**

Nets	1.17	1.13	1.29	1.44	1.08	1.75	1.63	1.58	1.50	1.50	1.50	1.44
HG	2.50	1.42	1.88	1.81	2.38	1.13	1.00	1.00	1.00	1.00	1.00	1.25

	Day	Night
HL	2.00	1.40
SP	2.00	1.40
OM	2.00	2.00

RECOMMENDATION

Considering the inshore fisheries survey provides information important for management and planning, it is recommended that this job be continued. Since approximately 10% of the participants and gear-units are not surveyed on the inshore participation route (based on FY98 data), it is recommended that the aerial surveys be continued. The sampling technique has improved since the initiation of the aerial surveys and an improved quantitative analysis has been completed for island-wide inshore fishing effort.

The increased availability and affordability of certain fishing gear methods has also changed on Guam. Hook and line has shown a significant increase since the early 1980's and has grown in popularity, especially with the i'e' and atulai fishery. Gill net use has remained high over the last decade, but the poor quality and disposability of the cheaper nets has created a situation of "ghost-netting" on our reefs. It is recommended that an increase in net dimensions, decrease fishing time, and reduction in net length, be made in order to reduce the overall destructiveness of this method. Inshore data compiled since 1985 supports the need for gill net restrictions because of the alarming reduction of certain species of finfish in the harvest estimates.

SCUBA spearfishing has increased in popularity with the aid of depth finders, bang sticks, and greater volume air-tanks. It is recommended for equipment restrictions be placed on spear SCUBA, e.g., banning of bang sticks and higher volume air tanks, in order to safeguard the rapid decline of our adult reef fish.

Overall declines in annual harvests and shifts in species composition have been documented in the last 14 fiscal years. With the recent legislative approval of marine preserves and the implementation of new fishing regulations, we can begin to manage

destructive fishing methods and preserve critical areas for reef fishes to mature and reproduce. As the success of the marine preserves are documented over the next few years, the evidence needed to restrict the most destructive methods, e.g. gill nets, drag nets, and SCUBA spearfishing, will be possible.

There may be an immediate need to modify inshore survey locations in the near future with the implementation of 5 new marine preserves on Guam. This may require the addition of approximately 5 new locations adjacent to the regions currently surveyed, e.g. locations 91, and 92 to region I; 35 to region II; and, 39 and 73 to region III, (Fig. 1).

PROJECT COST

The estimated cost of this project was \$159,000.

Report prepared by: Todd J. Pitlik

APPENDIX 1

INSHORE AERIAL SURVEY

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

A total of 24 inshore aerial surveys were conducted in FY98 for a total of 1,180 persons and 960 gear units. Hook and line was the most frequently encountered method with 601 persons and 598 gear units. A ratio of participants / method observed in areas outside the inshore participation route to the total number for all methods surveyed during the "inshore aerial" were calculated as variables (P_2 values) for the inshore expansion. The values ranged from 67% for weekday gill net to 100% for rare and night-practiced methods, e.g., surround net, drag net, other methods, and SCUBA spear fishing.

Incidental biological sightings resulted in a total of 219 turtles, 388 dolphins, 19 sharks, 14 eagle rays, 6 manta rays, and 4 sting rays for FY98.

BACKGROUND

Inshore fishing surveys have been conducted by the Division of Aquatics and Wildlife Resources (DAWR) since the early 1960's, to monitor and collect a long-term database on the total fishing effort and catch from Guam's reefs. The inshore-catch and inshore-participation surveys were developed to collect catch and effort data in near-shore areas easily accessible by motor vehicle. In addition, the inshore-aerial survey was established in the early 60's and reinstated in FY90 to survey effort in areas that could not be easily accessed by a vehicle.

PROCEDURES

"Inshore-aerial" surveys were conducted twice monthly on regularly scheduled participation days (one weekday / weekend). Start times are moved up in one-hour intervals for each subsequent survey (0800-1200h), then repeated after reaching 1200h. Visual observations of areas not covered in the "inshore-participation" survey (Fig.1 locations: 22, 27, 28, 35-39, 44-50, 58, 59, 70, and 73-92) included fishing effort data. The first scheduled weekday and weekend participation survey dates of each month were selected to allow rescheduling in the event of poor weather conditions.

Each survey started in location 11 and proceeded in a clockwise direction all the way around the island to location 12 (Fig. 1). The seaward flight distance from the reef margin was 200-300m with an altitude of 170-200m. The aerial itinerary also included a semi-circular flight pattern within Cocos Lagoon and Apra Harbor. In addition, the pilot was instructed to circle over reef flat areas when it was difficult to observe or determine activity.

The aerial survey observations were sorted by method and type day (weekday / weekend). A ratio of the persons / method observed in areas outside the inshore participation route were compared to the total number of persons / method observations for the island for each type day. The resultant P_2 values provided variables (%) that could be used to expand inshore participation values to island-wide participation values.

Other biological data collected, included incidental observations of marine mammals, turtles, sharks, and rays at or near the surface of various reef zones, e.g., Talafofo Bay and the fore reef slope, along the aerial survey route.

RESULTS

The most frequently encountered methods included hook and line, cast net, gill net, snorkel spear, hooks and gaffs, and other methods, while surround net, spear SCUBA, and drag net methods were less common. Ratio frequencies were highest (100%) for the least common methods, which were due to the rarity of their use during the day, e.g., spear SCUBA and drag net are primarily night methods. Hook and line, cast net, gill net, surround net, snorkel spear, hooks and gaffs, and other methods (weekday and weekend days respectively) had P_2 values (Table 1) listed as percentages: (90 / 83), (83 / 77), (67 / 77), (100 / 100), (81 / 91), (88 / 91), and (86 / 100), respectively for FY98.

Table 1. P_2 values derived from aerial survey data in FY98. Ratios were calculated from a ratio of method sightings within aerial locations to participation locations. Methods abbreviations are listed as follows: Hook and Line (HL); Cast Net (CN); Gill Net (GN); Surround Net (SN); Spear Snorkel (SpSn); Spear SCUBA (SpSc); Hooks and Gaffs (HG); Drag Net (DN); and Other Methods (OM).

Ratios	HL	CN	GN	SN	SpSn	SpSc	HG	DN	OM
Weekday	19/166	16/27	15/44	0/1	7/29	0/0	1/7	0/0	3/18
Weekend	70/346	14/52	29/100	0/79	5/53	0/0	2/20	0/0	0/14
WD Ratio	166/185	27/43	44/59	1/1	29/36	0/0	7/8	0/0	18/21
WE Ratio	346/416	52/66	100/129	79/79	53/58	0/0	20/22	0/0	14/14
WD P_2	90	83	67	100	81	100	88	100	86
WE P_2	83	77	77	100	91	100	91	100	100

Aerial survey counts indicated hook and line with the greatest number of participants in FY98 (Table 2).

Table 2. Total number of people and gear units observed during aerial surveys in FY98. Method abbreviations are listed in Table 1 with weekday (WD) and weekend (WE) days listed below.

Methods	Within Par Route				Outside Par Route			
	Persons		Gears		Persons		Gears	
	WD	WE	WD	WE	WD	WE	WD	WE
HL	166	346	168	341	19	70	19	70
CN	67	52	58	43	17	14	12	13
GN	44	100	16	33	15	29	8	10
SN	1	79	1	7	0	0	0	0
SpSn	29	53	29	53	7	5	7	5
SpSc	0	0	0	0	0	0	0	0
HG	7	20	7	20	2	3	2	3
OM	18	14	18	14	3	0	3	0
Total	332	664	297	511	63	121	51	101

Dolphins topped the list of the most frequently sighted marine animals during the aerial surveys with 388 sightings. The greatest monthly total of 82 dolphin sightings occurred in June. Turtle, shark, and eagle ray sightings ranked second, third, and fourth, respectively with annual sightings. The greatest monthly total of turtles and sharks were sighted in October with 32 and 4 respectively and eagle rays in August with 5. In addition, a total of 6 manta rays and 4 stingrays were sighted in FY98 (Table 3).

Table 3. Number of turtle, dolphins, shark, and ray sightings by aerial surveys around Guam in FY98.

SPECIES	MONTHS												TOTAL
	O	N	D	J	F	M	A	M	J	J	A	S	
Turtle	32	8	25	10	17	26	8	10	23	16	22	22	219
Dolphin	3	45	15	0	10	0	50	0	82	73	60	50	388
Shark	3	1	2	0	2	1	3	0	4	2	1	0	19
Sting Ray	0	0	2	0	0	0	0	1	0	0	1	0	4
Eagle Ray	1	0	0	0	1	0	0	3	2	0	5	2	14
Manta Ray	0	0	0	0	1	0	0	0	1	3	1	0	6

Cancellation due to poor weather conditions did not occur in FY98.

RECOMMENDATION

The number of fishermen counts during aerial surveys should improve if the flight pattern is modified from the outer reef margin to the mid-portion of large reef flats, e.g., Tumon, Ipan, and Piti reef flats.

PROJECT COST

Flights cost approximately \$9,500.

Report prepared by: Todd J. Pitlik

APPENDIX 2

KID'S FISHING DERBIES

PERIOD COVERED: 1 October, 1997 to 30 September, 1998

SUMMARY

Two marine fishing derbies for kids were held in FY98. The first event, co-sponsored by DAWR and COMNAVMARIANAS, was held on November 23, 1997 at Fena Lake, with a total of 26 participants. The second event, co-sponsored by DAWR and Andersen Air Force Base (AAFB), was held on May 30, 1998 at Sirena Beach, with a total of 32 participants. This was the ninth and tenth marine derby sponsored by the Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR). DAWR has co-sponsored six derbies with COMNAVMARIANAS and five derbies with AAFB.

OBJECTIVES

To encourage fishing as a form of recreation for children by promoting at least two kids fishing derbies per fiscal year, and to use these events as opportunities to teach environmental and fishing conservation ethics.

PROCEDURES

Coordination and Logistics

Derby preparation and planning took at least 4-6 weeks in advance. A fishing site and potential date had to be selected, which provided safe shoreline for the participants and good habitat for fishing. Fishing dates required an a.m. high tide to increase the chances of catching fish.

Kid's fishing derbies held in cooperation with military installations had individuals from both agencies serving as points of contact. This ensured that requirements of both agencies were met and that duties assigned to each agency were completed. Natural Resource Manager Leslie Morton of COMNAVMARIANAS, Chief Conservation Officer Dan Works of Andersen Air Force Base and DAWR Fisheries Biologist Veronica Cummings were the designated points of contact.

Logistics included providing: rest areas with chairs and tables as well as refreshments, staff to serve as officials, organizing a safety briefing and the awards ceremony, and ensuring that official representatives from both agencies were present for the awards presentation. Certificates of Participation and fish posters were provided to all participants. Draft post-derby report has been completed, which includes comments and suggestions from derby participants to improve future derbies.

Advertisements

The advertising strategy employed intended to ensure maximizing derby exposure to children ages seven to twelve both on and off base. This was done by providing flyers to all elementary and middle schools, having highway banners displayed in strategic locations, providing the media with press releases periodically, and making derby pitches through various radio talk shows.

Derby Rules and Clinic

The derby had a harvest size limit and a bag limit for the fish caught to encourage the practice of conservation. Fish had to be over 6 inches (152 mm) in length in order to qualify for the derby awards and to be kept. Although there was an individual bag limit of five fish, participants were encouraged to practice “catch and release” during the event.

The derbies were open to children from seven to twelve years of age, and was preceded by a fishing clinic open to the public on November 15, 1997 and May 23, 1998. The fishing clinic provided an opportunity for parents and children to learn about and practice basic fishing skills including knot-tying and casting. Demonstrations were also conducted to aid parents in selecting and purchasing fishing gear and in preparing for the fishing event.

RESULTS

Twenty-six children participated in the November 23 derby and 32 children participated in the May 30 derby.

Derby results are listed in Tables 1 and 2. Prizes for the derby were solicited for a two-day event in accordance with Executive Order 91-08, resulting in thirty-seven prizes being donated. Since there were only six winners from the actual fishing, the remaining prizes were distributed by lottery to the non-winners. Food was also donated by businesses, with donuts and soft drinks being provided as refreshments.

Table 1. Winners in November 23, 1997 Kid's Derby

MOST FISH on SUNDAY		
First Place	Chelcy Reyes	3 fish
Second Place	Jadine Leonen	2 fish
Third Place	Alex Boudreau	1 fish
<u>LONGEST TILAPIA</u>		
First Place	Gene Gozalo	9.96 inches
Second Place	Christen Calvo	9.06 inches
Third Place	Justin Evangelista	6.85 inches
<u>LONGEST TUCUNARE</u>		
<u>None caught</u>		

Table 2. Winners in May 30, 1998 Kid's Derby

MOST FISH on SUNDAY		
First Place	Raymond Blas	3 fish
<u>LONGEST FISH</u>		
First Place	Chelcy Reyes	9.3 inches
Second Place	Chauncey Celis	7.7 inches
<u>LONGEST TRIGGERFISH</u>		
First Place	Alexander Numann	7.7 inches

RECOMMENDATIONS

Evaluations and Comments

November 23, 1997 Derby

1. Very Good. Do more often. Need to do more advertising announce through schools, Boy Scouts, & Girl Scouts. We have participated in each one since we have been here on Guam (2 yrs.). Good work staff. Good Job for providing access to area not easily accessible (U.S. military lands). Jack Kuhn.
2. Parents should fish. Should be able to use boats.
3. Well organized, organizers are very helpful & courteous. We really enjoyed.
Suggestions/Recommendations:
 - Improve fishing are by clearing moss. Extremely difficult for young kids to throw far enough to clear it.
 - Longer fishing time.
4. This is the second fishing derby my sons (3) have had the opportunity of enjoying. I'm thankful to all those who in one way or another made it possible. I hope to see more derbies and hope the sponsors keep up. Would you consider holding a derby for older children 13-15 years old? My oldest son always feels left out.
5. I thought it was well run and fun overall. Conditions were a bit difficult for children this age. I also don't really like rule changes once they're established. Changes from 2 to 1 day. Extended registration etc. Would have been nice to been facing away from the sun on the other side! Rand and Rafael Friedenfels.
6. Great opportunity for the kids & parents as well. Fena is a great beautiful lake with peaceful surroundings. It was nice for the families to enjoy the fishing derby together & have opportunities to catch fish. Next time we will find worms!!! Mark & Jackie Thompson.
7. It was very interesting, especially being a lake. Very challenging and a good experience.
8. Make accessible areas better (clearer).
 - Only recommend long sleeve shirts on rain days --very hot for the kids.
9. These activities are always very good. We just need to do a lot more throughout the year. My only recommendation is to make the time (fishing) a little longer. Felix Reyes.
10. Just a big thank you for this wonderful program. We enjoyed it. Fena Lake nice place to enjoy the scenery. To all the staff involved, as always, good job.
11.
 - Use of boats would make it so the kids don't get stuck in the grass.
 - An excellent event my kids had a lot of fun.
 - I think you have great support from you sponsors. Thanks & we'll be back! Ted Boudreau.
12. Well run event!! Great job!! Thank you!! Dennis Ferree.

13. More area needed for fishing. Have a portable toilet. Overall good job - Have at least quarterly or twice yearly.
14. - Too much moss/weeds. Especially troublesome when children are fishing.
- Staff was helpful and friendly. Jeff Mathes.
15. It was nice and lots of fun for my daughter. She wishes she could do it more often.
Paul C. Aguon.
16. This was a good experience for the kids it should happen more often. Prizes were great and the coordination was too.

May 30, 1998 Derby

1. This is a worthwhile event and we enjoyed it. Not many fish were caught today, probably a bad day for the fish. The coral made it easy to get the hooks caught or stuck. It didn't seem easy to fish from the shore, a dock would be better.
Anonymous
2. We wish a lot more kids participate. We've always enjoyed ourselves. Increase frequency at AAFB as it is a good location. How about a golf course pond fishing?
Felix Reyes
3. Fish were kinda shy today, but my son and I enjoyed our time trying to catch what's in the water. Many thanks to all responsible for this fun time. Brian and Ben Carbullido.
4. Excellent, as usual. Anonymous
5. This event was enjoyed by young and older alike. This gives guardians and role models the opportunity to share their knowledge of conservation, the ecology and the skill of fishing correctly. The only thing I didn't see was a recycling bin for aluminum cans. Leigh Kuhn.
6. It's a good program. It gives parents and kids an opportunity to have fun. Unfortunately, the fish did not cooperate today. We're looking forward to fishing at Fena. Rey Llaneta.
7. Extend the fishing time. Overall, it was a worthwhile event. Thanks. Anonymous.
8. Eventhough we didn't catch any fish, we still had a good time. Keep the program going. You may want to plan the next one when the tide is right for fishing. Rich and Zach Mele.
9. Excellent! Good way of exposing kids to nature, & a great way of getting parents and their children together. Great outdoors sport. Mike Napoli
10. We enjoyed fishing today, although we caught some of which didn't make the size category. The tide wasn't at its peak till later, maybe next time it's better if it's high early like say 6-7 a.m., no later.
11. We had a good time. Thanks for all your effort. It is good for the kids. Jerome Quigley.

12. Well organized - Do it more often. Scott Klassen
13. Well it is very much good for the kids because they have their time for derby. Likewise it is very good. Tony Quichocho, Jr.
14. Given how few fish are caught sometimes, it might be better to count all fish - no 5" minimum rule. Andrew & Trevor Torres.
15. My son enjoyed the fishing even though we didn't catch any fish. Thank you. John & Kevin Titus.
16. Have it earlier. Good Job. Have more of them. Have an event for older kids. Anonymous
17. Get more parents motivated. The program directly to the school, guest speakers in the 5th grades. All of the help & organization was excellent! Fish at night. Fish from 4 am to 9 am. Fish longer. Andrea J. Larned

The derby program has been well received and is a valuable educational tool for those who participate. However, an increase in the number of participants is essential for the program to effectively continue. This can be achieved by adding radio advertisements to our other methods of advertising. In addition, hosting more events and targeting special groups like the Boy Scouts, Girl Scouts, or village programs could work well.

Another factor concerning participation in derbies is to find a location that is more centrally located, instead of going to strictly military sites.

The response from participants and parents was positive. There have been requests by participants and parents to include a category for teenage anglers. Some of the older participants are interested in staying in the program, while some parents have older children who usually help their younger siblings to fish. This might help in making the derby more family oriented and decrease the chance of turning away potential participants.

PROJECT COST

The estimated cost of this project is \$2,000.

Report Prepared by: Veronica Cummings

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-6
SUB-PROJECT NO.: F-2
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Freshwater Monitoring (2440)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

During FY98, the four previously selected watersheds were re-sampled. Faunal counts and habitat characteristics recorded in FY98 are summarized. The influence of Fena Reservoir on migrating fauna continues to be assessed. The results of the FY97 study were used as baseline data in comparative analyses with data collected in FY98.

BACKGROUND

Maintaining high quality watershed ecosystems is essential to protecting healthy coastal areas, which support fisheries. In order to monitor the quality of Guam's watershed ecosystems, biological and physical baseline data were collected from the following four watersheds in FY97: 1) Fena; 2) Manenggon; 3) Ylig; and 4) Pago. Annual monitoring of these parameters is essential for the effective watershed management that is necessary to protect Guam's coastal resources.

Further explanation regarding the purpose of the project and additional background information can be found in Freshwater Monitoring Annual Report (F-1R-5, F-2, 1-1).

OBJECTIVES

1. Continue to survey the four watersheds chosen in FY97, in order to monitor the health of stream ecosystems on Guam.
2. Continue to monitor the effect of Fena Reservoir on faunal migration.
3. Begin preparations for a stock assessment of Fena Reservoir.
4. Develop a more extensive freshwater field guide, building on information collected in FY97.

PROCEDURES

- 1-2. Species composition, organism density, and habitat characteristics were collected in the experimental and control rivers chosen in FY97, using the methods described in the annual report of FY97. The experimental rivers, located above Fena Reservoir, are: the Almagosa River, the Maulap River, and the Sadog River. The control rivers are: the Maagas River, the Manenggon River, the Pago River, and the Ylig River. When possible, analysis of variance was used for data comparison of the streams. However, when the data did not conform to the assumptions of ANOVA, appropriate

non-parametric tests were performed (StatView 4.51, Abacus Concepts, Inc., Berkeley, California, 94704-1014).

3. Preparations for the stock assessment of Fena Reservoir commenced in FY98. Various methods were researched and potential sites were explored. A mark-recapture method was chosen and the required materials were procured. The stock assessment will be performed in the dry season of FY99 (January - May). Methods and materials will be tested prior to implementation of the project.
4. Methods of photography were explored for use in compiling the freshwater field guide in FY98. Specimens were collected from several sites around the island and photographed in a v-shaped glass aquarium using various types of lighting, backgrounds, and ways to immobilize the organisms (i.e. anesthetics, reduced temperature). Additionally, some organisms were photographed *in situ* with an underwater camera.

RESULTS

Significantly fewer species per square meter were seen in all rivers in FY98 than in FY97 ($p < 0.01$; Fig. 1). However, there was no significant difference between FY97 and FY98 for total density in all rivers ($p > 0.05$; Fig. 2). The gobies *Mugilogobius cavifrons* and *Sicyopus leprurus*, the tucunare *Cichla ocellaris* and species of neritid gastropods were not recorded in any surveys. The Guam goby *Awaous guamensis* was the only species seen in all streams surveyed.

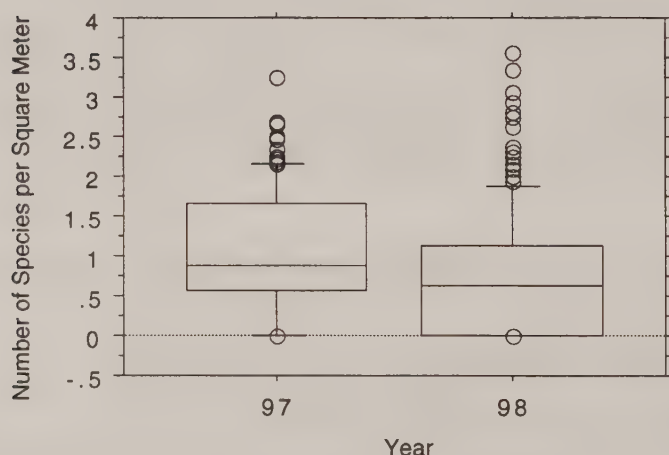


Figure 1. Mean number of species per square meter, in all rivers surveyed, grouped by year.

Both species density and total density did not differ significantly between experimental and control streams ($p > 0.05$; Figs. 3 and 4). Individually, densities of *A. guamensis*, the mountain goby *Stiphodon elegans*, the tilapia *Tilapia zillii* and the freshwater prawn *Macrobrachium lar* did not differ significantly between experimental and control rivers ($p > 0.05$). The flagtail *Kuhlia rupestris* and the eel *Anguilla marmorata* were present only in the control streams. The tilapia *Oreochromis mossambicus* was present only in experimental streams. Although *S. elegans* appeared to be more associated with harder substrate types, it was not found on these substrates significantly more often than on softer

ones ($p > 0.05$). Similarly, there was no significant difference between substrate types for *A. guamensis*, which is normally found on sand or silt ($p > 0.05$).

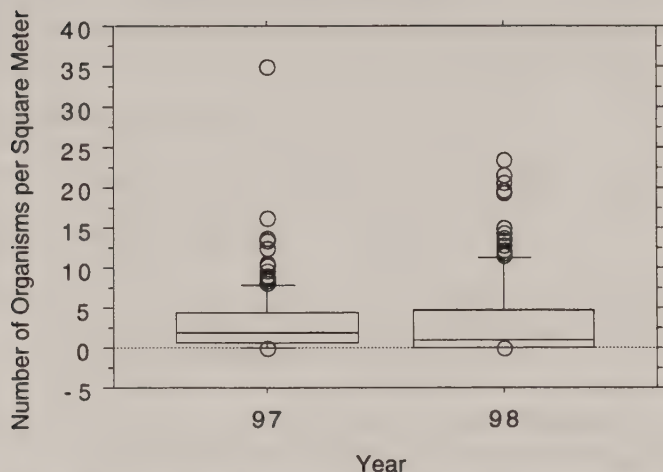


Figure 2. Mean number of organisms per square meter, in all rivers surveyed, grouped by year.

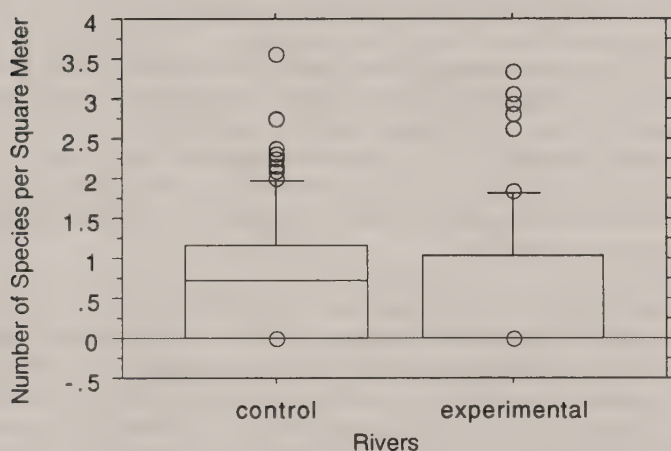


Figure 3. Mean number of species per square meter grouped by rivers. Experimental rivers are located above Fena Reservoir.

DISCUSSION

Mean species density was significantly lower for all rivers combined in FY98 than in FY97. This may be due in part to the effects of Supertyphoon Paka, which discharged 22 inches of rain in approximately 12 hours on 16 December 1997. This excessive rainfall caused flooding in most of Guam's rivers. The increased water volume and velocity may have flushed organisms out of the rivers. Covich, et al. (1991) reported that shrimp densities decreased by an average of 50 percent in the headwaters of a Puerto Rican stream one month after the passing of Hurricane Hugo. Our river surveys were conducted in February and March of 1998. The species surveyed may have been the first to recruit back up the rivers. Conversely, total density did not differ significantly between years. This

may reflect that fewer species present are able to occur in higher numbers due to decreased competition.

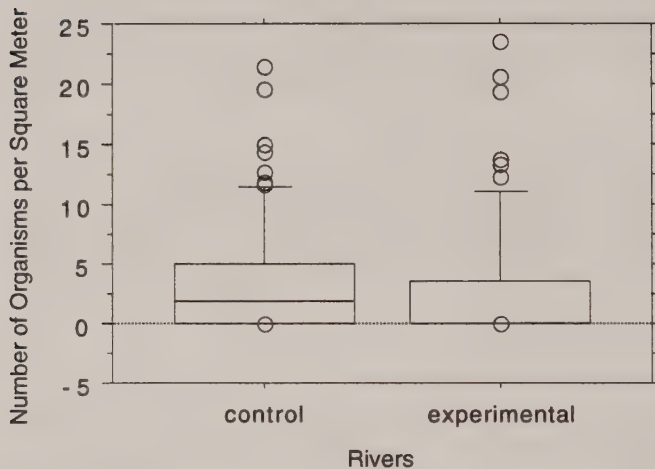


Figure 4. Mean number of organisms per square meter grouped by rivers. Experimental rivers are located above Fena Reservoir.

Densities for a majority of species did not differ significantly between experimental and control streams. Two species occurred only in control streams. The dam probably excludes *K. rupestris*, because it is not morphologically adapted for climbing. It is also absent above natural waterfalls in most streams of Guam. *Anguilla marmorata* was seen above the reservoir but not in surveyed sites. Eels were certainly underrepresented in our daytime surveys due to their nocturnal activity. *Oreochromis mossambicus* was found only in experimental rivers. It was introduced into Fena Reservoir in 1956 (Nelson and Eldredge, 1991), but has not been restricted to areas above the dam. It was also seen in control rivers but not within quadrats surveyed.

Previous studies have shown that species of *Awaous* and *Stiphodon* are found more frequently on certain substrate types (Kinzie, 1988; Parham, 1995). In this study, there was no significant difference between substrate types associated with either *A. guamensis* or *S. elegans*. This is difficult to explain because the substrate types normally associated with these fish are suited to their mode of feeding and escape behavior. These species may have been able to exploit a greater variety of substrate types due to the presence of fewer potential predators or competitors.

RECOMMENDATIONS

This study continues to suggest that dams and reservoirs in tropical streams may not have severe effects on most species. However, these ecosystems are complex and there can be high variability between streams and between years. Annual monitoring of these watersheds should continue in order to clarify ambiguous results seen so far.

A stock assessment will be implemented in FY99. The assessment should include the search for unknown species as well as the determination of densities of known species.

Discussion with the U.S. Navy will be required in FY99, in order to reestablish public access to fishing at Fena Reservoir.

Literature compiled for the freshwater field guide should be condensed into a practical form. Digital technology should be explored for production of the guide.

This project should move towards integrating freshwater monitoring with coral reef protection. This entails investigating the rate of erosion and sediment loading in our streams in order to obtain a clearer understanding of depositional rates on adjacent coral reefs.

PROJECT COST

The estimated cost is \$72,000.

LITERATURE CITED

Covich, A.P., T.A. Crowl, S.L. Johnson, D. Varza, and D.L. Certain. 1991. Post-Hurricane Hugo increases in atyid shrimp abundances in a Puerto Rican montane stream. *Biotropica* 23: 448-454.

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This report was prepared by: Trina J. Leberer

JOB PROGRESS REPORT COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-6
SUB-PROJECT NO.: F-3
JOB NO.: 1

JOB TITLE: Technical Guidance to Projects Affecting Guam's Fish Resources (2710,2720)

PERIOD COVERED: October 1, 1997 to September 30, 1998

BACKGROUND

The Division of Aquatic & Wildlife Resources' (DAWR) professional Fisheries Staff devoted a significant percentage of their time and effort to technical assistance to fulfill the statutory responsibility to review and comment on development plans, rezoning applications, and various permit applications. Because of the size and complexity of some of these developments, the Fisheries Staff's review responsibility requires a continuing commitment that could extend even beyond project completion.

The Division's Technical Assistance Program (TAP) within the Administration/Coordination Section remained unstaffed due to funding. The work has been transferred to the Agricultural Development Services (ADS) Division. ADS coordinates with fisheries on issues requiring such expertise. The professional staff within the Fishery Section provide technical support to the ADS staff, and occasionally take the lead in the review of projects involving their particular expertise, such as those that may have endangered species (sea turtles) impacts and those involving coral reefs.

OBJECTIVES

1. To minimize adverse environmental impact resulting from the construction of recreational, commercial, residential, industrial or public utility facilities.
2. Provide technical assistance to military and civil agencies relative to the management and protection of fish resources.

FINDINGS

Fisheries Staff have been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications have been submitted to the Division for review. Field investigations and meetings with responsible agencies have been conducted in many cases as a part of the review process.

Various Fisheries Staff members actively serve as members of the following groups:

- 1) Recreational Water Use Master Plan
- 2) Western Pacific Regional Pelagic Plan Monitoring Team
- 3) Western Pacific Regional Bottomfish Plan Monitoring Team

- 4) Federal Data Coordinating Committee
- 5) The Coral Reef Initiative Technical Support

Members of the Fisheries Section attended 68 meetings and made 34 field inspections during FY98 pertaining to the protection of Guam's natural resources. Additionally, staff have continued to actively consult with various civil and military agencies on environmental matters. Division staff maintain close liaison with the Department of Land Management, Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency, University of Guam, U.S. Army Corps of Engineers (ACOE), U.S. Fish and Wildlife Service, Western Pacific Regional Fisheries Management Council, National Marine Fisheries Service, U.S. Navy, the U.S. Coast Guard, and U.S. Air Force regarding matters of environmental concern. In addition, staff members actively consulted with the numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

- 1) Considerable public contact was maintained by Fisheries Staff during the reporting segment. In addition to occasional interviews on radio, television, and in the newspaper, they also gave talks to a number of civic groups, and schools. Some specific Technical Assistance activities provided by the Fisheries Section included:
- 2) Technical support to the Divisions ADS staff who represents the Department and the Division on the ARC, which met bi-weekly to review applications for rezoning, variances, and various types of development.
- 3) Offered comments and provided information to the Western Pacific Regional Fisheries Management Council (WESPAC) and the Plan Monitoring Team (PMT) on projects for bottom and pelagic fisheries. Information was provided on market sampling, and stock assessment, and from recreational and near-water commercial vessels. Staff attended 5 off-island, Council related meeting.
- 4) Reviewed and commented on two proposed bills that would affect fisheries.
- 5) Investigated two suspected fish kills in island waters during the year.
- 6) Responded to 19 requests for information on laws and regulations pertaining to fish, endangered species, fishing and importation of fish.
- 7) Made 47 presentations on fish resources to other organizations or groups during the year.
- 8) Provided statistical data on fisheries issues to the Bureau of Planning and Department of Commerce on a quarterly basis.

RECOMMENDATIONS

To ensure that salary funds are maintained to ensure that ADS can continue spearhead this program at the Department.

PROGRAM COST

The estimated cost of the project is \$25,000.

Report prepared by: Gerald W. Davis

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-6
SUBPROJECT NO.: F-4
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Stock Assessment Surveys of Marine Preserves and Control Sites

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

During FY98, initial planning for the Marine Preserve Fish Assessment Surveys had begun.

Of Guam's five marine preserves (Figure 1), fish assessment surveys will be conducted at the Piti Bomb Holes Preserve and the Achang Reef Flat Preserve. The surveys will be divided into two habitat types: the reef flat and the fore reef slope. The reef flat habitat will be divided into microhabitats such as sandy bottom, seagrass beds, and coral/rubble habitats. The control site chosen for the reef flat at the Piti Bomb Holes Preserve is Cocos Lagoon, the control site chosen for the Piti Bomb Holes Preserve fore reef slope is the Asan fore reef slope (area closer to Adelup), the control site chosen for the Achang Reef Flat Preserve reef flat was the Pago Bay reef flat, and the control site chosen for the Achang Reef Flat Preserve fore reef slope was the Atao Beach fore reef slope. Field surveys were conducted at a variety of sites until suitable control sites could be selected. Fish assessment surveys will also be conducted near the Piti Observatory since feeding practices appear to be aggregating fish.

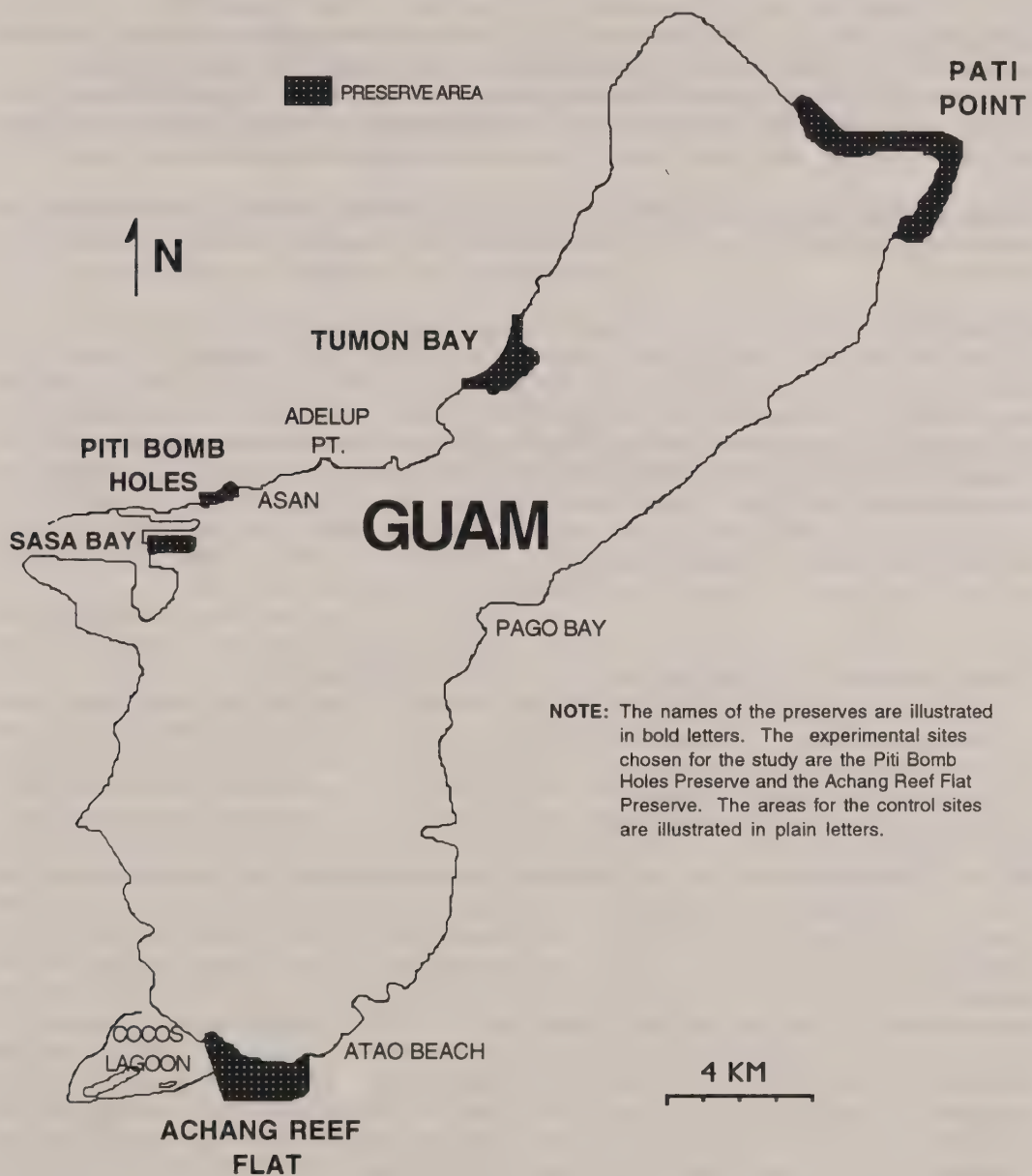
A visual fish survey was chosen: reef flat surveys and fore reef slope surveys will consist of 50 m X 5 m strip transects. To augment the results of these surveys, interval counts, filming with an underwater video camera, and photo-sampling of substrate will be conducted. The fish species to be surveyed are the important food fishes and the butterflyfishes since they usually serve as indicators of coral cover.

BACKGROUND

In order to restore fish stocks in the coastal areas around Guam, Bill No. 49 (COR) was signed into law on May 12, 1998 as Public Law 24-21 establishing five marine preserves and making changes to Guam's fishing regulations. The names of the preserves are the Pati Point Preserve, the Tumon Bay Preserve, the Piti Bomb Holes Preserve, the Sasa Bay Preserve, and the Achang Reef Flat Preserve. Under P. L. 24-21, the Department of Agriculture is required to monitor the areas for two years to determine the effects of the marine preserves on food fish populations and report the findings to the legislature. To monitor the effectiveness of marine preserves in restoring a dwindling fishery and heighten public awareness, stock assessment surveys of the marine preserves and control sites need to be conducted. The justification for the marine preserves came from data obtained from the Inshore Fisheries Survey Project (F-1R, Subproject F-1, Study 1, Job 2).

GOVERNMENT OF GUAM DEPARTMENT OF AGRICULTURE
DIVISION OF AQUATIC AND WILDLIFE RESOURCES

FIGURE 1. GENERAL AREAS OF EXPERIMENTAL AND CONTROL SITES



OBJECTIVE

To evaluate the effect on sport fish populations caused by the creation of marine preserves.

PROCEDURES

Initial planning for the stock assessment surveys of the marine preserves involved choosing control and experimental sites, habitat types to sample, and sampling methods. The professors from the University of Guam marine lab were consulted to provide insight into the plans. Literature on marine preserves, papers on marine biological surveys on Guam, and maps of Guam's reefs and beaches were also obtained and reviewed.

Fieldwork was conducted on the reef flat to determine if the control and experimental sites chosen were similar. The use of different sampling markers were also explored and discussed.

RESULTS

From meetings held with the professors from the University of Guam marine lab, the Piti Bomb Holes Preserve and the Achang Reef Flat Preserve were chosen as the experimental sites for the fish assessment surveys. The two preserves were chosen as experimental sites because no fishing is allowed at all within these preserve as compared to the Tumon Bay Preserve and the Pati Point Preserve in which limited fishing is still allowed. The Sasa Bay Preserve was not considered due to poor visibility in the water. The reef flat and the fore reef slope are the two habitats chosen for the survey. Within the reef flat, the sandy bottom, the seagrass beds, and the coral/rubble habitats are to be surveyed.

From discussions between Agriculture staff and from obtained literature, control sites were chosen for the two experimental sites. Reef flat for Piti Bomb Holes Preserve = Cocos Lagoon; fore reef slope for Piti Bomb Holes Preserve = Asan fore reef slope (area closer to Adelup); reef flat for Achang Reef Flat Preserve reef flat = Pago Bay reef flat; fore reef slope for Achang Reef Flat Preserve = Atao Beach fore reef slope. Fish assessment surveys will also be conducted near the Piti Observatory since feeding practices appear to aggregate reef fish. Figure 1 depicts the general areas of the experimental and control sites.

Visual sampling methods were suggested as potential methods for the fish assessment surveys: strip transects, stationary point counts, interval counts, and underwater video cameras. Strip transects 50 m X 5 m were chosen as the primary method to estimate fish abundance over time because of all sampling methods for reef fishes, the use of strip transects has received the most intensive analysis of precision, accuracy, efficiency and data attributes (Cappo, Michael and Brown, Ian W. 1996). Interval counts, the use of an underwater video camera, and a photogrammetric method to sample substrate will be conducted to augment the presentation of survey results. The interval counts will be conducted for species diversity, sites will be filmed with a video camera to provide a before and after visual representation over the study time period, and substrate sampling will be conducted to depict the status of the biota within defined habitats at a given time. The important food fishes and the butterflyfishes, since they usually serve as indicators of coral cover, were chosen as the fish species to survey for the assessment.

Similarities were exhibited between the control and experimental sites when field surveys were conducted on the reef flats of the Piti Bomb Holes Preserve, Pago Bay, Achang Reef Flat Preserve and Cocos Lagoon. The different habitat types and potential areas to sample within the control and experimental sites were noted.

RECOMMENDATIONS

- 1) Practice survey methods to ensure comfortability with the methods and to incorporate any modifications, if needed.
- 2) It is recommended that a new boat be purchased as soon as possible for the Department of Agriculture so surveys on the fore reef slope and Cocos Lagoon can be conducted. It is also recommended that the new boat be longer than 20 ft., able to carry six to eight passengers/divers, and capable of handling seas on the east side of the island. Agriculture's old boat, the 20 ft. Corwin, does not meet all these requirements and is inoperable at this time.
- 3) Since the deadline for submitting requisitions for FY98 has ended, it is recommended that as soon as requisitions can be accepted for FY99 that they be submitted to obtain materials needed for the fish assessment survey.
- 4) It is recommended that different sampling markers be considered due to the fact that some of habitats to be sampled for the survey are on sandy bottoms and seagrass beds.
- 5) It is recommended that memorandums be sent to the University of Guam marine lab and to the Department of Parks and Recreation to request the use of their boats for the surveys.

PROJECT COST

The estimated cost of the project is \$15,000.

Report prepared by: Jay T. Gutierrez

LITERATURE CITED

Cappo, Michael and Brown, Ian W. 1996. Evaluation of sampling methods for reef fish populations of commercial and recreational interest. CRC Reef Research Tech. Rep. No. 6. 72 pp.

JOB PROJECT REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-2-D
SEGMENT: 7

PROJECT TITLE: Merizo Pier and Boat Ramp Facility (2331)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

The Merizo pier and boat launching ramp facility is used extensively by the public. Damage from vandalism, exposure to the elements, and heavy use makes it necessary to renovate the parking facility, replace the damaged boat launching ramp with a larger ramp, and repair the pier's rubber bumpers, lighting, and electrical system. Proposals to renovate and repair these facilities were submitted to the Department of Administration in FY95, then submitted to the Department of Public Works in FY96. In FY97, final engineering plans and specifications were approved by the Department of Public Works and a contract for the project was awarded. During FY98, the contract to repair the pier and renovate the boat ramp and parking facility was awarded to Rex International Corporation. The project is being administered by the Department of Public Works and should be completed during FY99.

OBJECTIVES

To repair the Merizo public pier and replace the existing recreational boat ramp facility with a new multi-lane boat launching ramp and an improved parking facility.

RESULTS

During FY97, the final engineering plans and specifications for the renovation of the Merizo boat launching ramp facility and the repair of the Merizo pier were completed and approved by the Department of Public Works. The contract for the project, Project No. 350-5-1019-L-MER entitled "Upgrading of the Merizo Boat Launching Ramp Facility (Design-Build) and Repair of Merizo Pier," was awarded to Rex International, Inc. for \$678,200. During FY98, the damaged upper rubber bumpers on the south side of the pier were repaired and replaced, and the damaged lower rubber bumpers around the entire pier were removed and replaced with the bumpers attached to galvanized channels rather than cresol treated wood. Also, the electrical system on the pier was upgraded and damaged light posts replaced. During FY98, the permitting process to replace the damaged single lane boat ramp and renovate the parking facility was completed. The Department of Public Works will issue a Notice to Proceed during early FY99, and the project should be completed during FY99.

An additional work item was also awarded to Rex International, Inc. during FY98 to remove and dispose of the present ladders on the pier, replacing them with ladders constructed of two-inch galvanized pipe, similar to the ladders used at the Agat Marina. The present ladders on the pier have been damaged yearly from corrosion and heavy use, especially from large boats tying on them rather than using the pier cleats. Also, two ladders were intentionally bent and used as makeshift springboards. The new ladders are

necessary to withstand the heavy use by the public. This project should be completed during FY99.

RECOMMENDATIONS

During FY97, it was recommended that a vehicle barrier be placed at the front of the pier to prevent unauthorized vehicles, including large commercial trucks, from driving onto the pier. It is recommended to complete this during FY99. Also, damage done to the lights on the south end of the pier could have been caused accidentally by fishermen hitting the lights while casting with lead weights. The light posts should be inspected periodically for this type of damage, and perhaps some sort of barrier be designed and placed around the light assembly. Several cleats on the pier were pulled out and bent out of place during FY98. The cleats were not damaged, but the lag screws anchoring the cleats to the pier were damaged. Cleats on the pier, which are used more extensively and have been regularly bent should be replaced with cleats having larger anchors during FY99.

PROJECT COST

The estimated cost of this project was \$178,122.

This report was prepared by: Thomas Flores, Jr.

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SEGMENT: 2

JOB TITLE: Development of Inshore Fishing Access Facilities (2331)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

During FY98, the mayor of Talofofo was contacted to schedule a meeting with the municipal planning council to gain support for constructing the two fishing platforms adjacent to Togcha Cut. After numerous attempts, the mayor wrote a memorandum to waive the municipal planning council meeting. The Department of Land Management (DLM) was contacted to schedule the public hearing and decided that they wanted to have all villages within the fishing platform program receive public hearings at or about the same time. Our office has been in contact with the DLM to arrange for meetings with the municipal planning councils to schedule public hearings.

BACKGROUND

The historical and traditional use along with design, site selection, environmental review and status of application to the Territorial Seashore Protection Commission has been discussed in previous fiscal year reports (Kruckenberg, 1989-1997).

OBJECTIVE

Plan, design and construct inshore fishing access facilities (reef flat platforms and cliff platforms) in the coastal areas of Guam

PROCEDURE

During FY98, our plan was to meet with the municipal planning council at Talofofo and ask for a public hearing in the village. After numerous times to get the agenda with the council and being hit with Typhoon Paka, the mayor of Talofofo wrote a memorandum to the Director of Agriculture, requesting to waive the municipal planning council meeting. At that time, our office contacted the DLM to schedule a public hearing.

RESULTS AND DISCUSSION

The DLM was contacted to schedule a public hearing and decided that they wanted them for all proposed sites at about the same time. After the DLM has gathered the proper information, the municipal planning councils and mayors in each respective village will be contacted to review the proposal and may schedule the public hearings.

RECOMMENDATIONS

The Division recommends that the fishing platform program continues, to improve the safety and increase the fishing opportunities for inshore fishermen. After proper approvals have been granted through the public hearings in each village and the Guam Land Use Commission, the project will be put out to bid for construction.

PROGRAM COSTS

The estimated cost of the Platform Project was \$11,475.

Report prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SEGMENT: 10

JOB TITLE: Masso Reservoir Restoration (2322)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

In FY98, Duenas & Associates has submitted initial 30%, 60%, 100%, pre-final, and final plans for the Masso Restoration project. The federal and local permitting is nearly complete and the project will be put out to bid after approval by the Guam Land Use Commission (GLUC).

BACKGROUND

The project will enhance sportfishing opportunities and/or protect the freshwater finfish resources at Masso Reservoir. The history and status of the Masso Reservoir Project was outlined in previous job progress reports (Kruckenberg, 1993 - 1997). The project involves dredging of the reservoir, rehabilitation of the water control gate structure, construction of a cofferdam, development of the area for public access and the shoreline for fishing.

OBJECTIVE

1. To provide an easily accessible freshwater fishing facility at Masso Reservoir.

RESULTS

Duenas & Associates had submitted initial 30%, 60%, 100%, pre-final, and final plans for the Masso Restoration project. At the completion of each level, comments were prepared and a meeting held to discuss the plans. They were also held responsible for preparing and submitting all permit applications and clearances with the federal and local governments (Section 401 Water Quality Certification, Wetland Permit, Guam Coastal Zone Management Program, Department of the Army (DOA) Permit, Section 7 Consultation, and GLUC). Our office played an active role in the processing and completion of the permits and approvals. The project is on the agenda for the GLUC meeting for 1 December 1998 to seek approval for the Wetland Permit. If approved, the Section 401 Water Quality Certification can be granted for the project to proceed. In addition to the above-mentioned activity, a 10.9 acre WHIP Reforestation Project was initiated by our office with cooperation from the Forestry Division at the DOA and the US Department of Agriculture – Natural Resources Conservation Service. If approval is granted, the project will be tasked to reforest a small drainage above the reservoir to prevent sediment loading in the adjacent wetland and aquatic resources.

RECOMMENDATIONS

This program has valuable freshwater fishing potential for Guam while providing a safety factor and enhancing fishing opportunities. It is recommended that this job continue to develop a freshwater reservoir on Guam for sport fishing.

PROGRAM COSTS

The estimated cost of the Masso Reservoir restoration project to date is \$89,876.

Report prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-2-D
SEGMENT: 11

PROJECT TITLE: Fabrication and Deployment of Shallow Water Moorings (2331)

PERIOD COVERED: October 1, 1997 to September 30, 1998

OBJECTIVE

To develop a shallow water mooring program at popular fishing and recreational diving locations to minimize anchor damage to reef habitats.

SUMMARY

Figure 1 provides an updated list of the shallow water mooring (SWM) sites and maps their approximate locations; Figures 2-10 provide a more detailed illustration of each site. Some sites may be deleted from the list at a later time if they are found to be in areas no longer suitable for fishing or diving, or are determined to be in conflict with local, federal, or military regulations or program objectives.

Figure 11 illustrates the design of the SWM systems to be used and their components. The smaller, more economical Type I buoy design will be used for sites outside of Apra Harbor because of its ability to withstand rough seas and typhoon conditions. The Type II buoy design on the other hand, places much more strain on the mooring system in rough conditions and thus may be reserved for use in Apra Harbor only. The type of anchoring system used for either type of buoy will be determined by the type of substrate at the selected anchor site: a cemented eye bolt for uneven rocky substrate, or a "Manta Ray" anchor for flat sandy sites.

On March 13, 1997, DAWR submitted an application for an Army Corps of Engineers General Permit for the SWM project. In late-April DAWR was informed by ACOE that the U.S. Coast Guard objected to the location of a majority of the sites in the original proposal because they were situated in areas frequently transited by small vessels. As a result, the Coast Guard would require DAWR to equip each SWM buoy with a navigation light if the project were to proceed as proposed. In response to this objection, DAWR amended the original proposal to relocate the proposed anchor sites in question closer to shore and at depths less than ten fathoms (60 feet). The relocation of the sites into shallower water was eventually found by the Coast Guard to pose much less of a threat to navigation and thus obviated the need to install navigation lights on the buoys. Having addressed this concern, DAWR received ACOE authorization on October 15, 1997, to proceed with the project with the provisions that 1) the Guam Bureau of Planning issue a CZM Consistency Statement for the project (which had already been issued on April 7, 1997), and 2) the Navy authorize the installation of SWMs on Navy submerged property.

Although, the relocation of the buoys into shallower waters served to address initial Coast Guard objections, the modification necessitated additional authorization by the Guam Seashore Protection Commission (GSPC) since the sites were now in waters less than 60

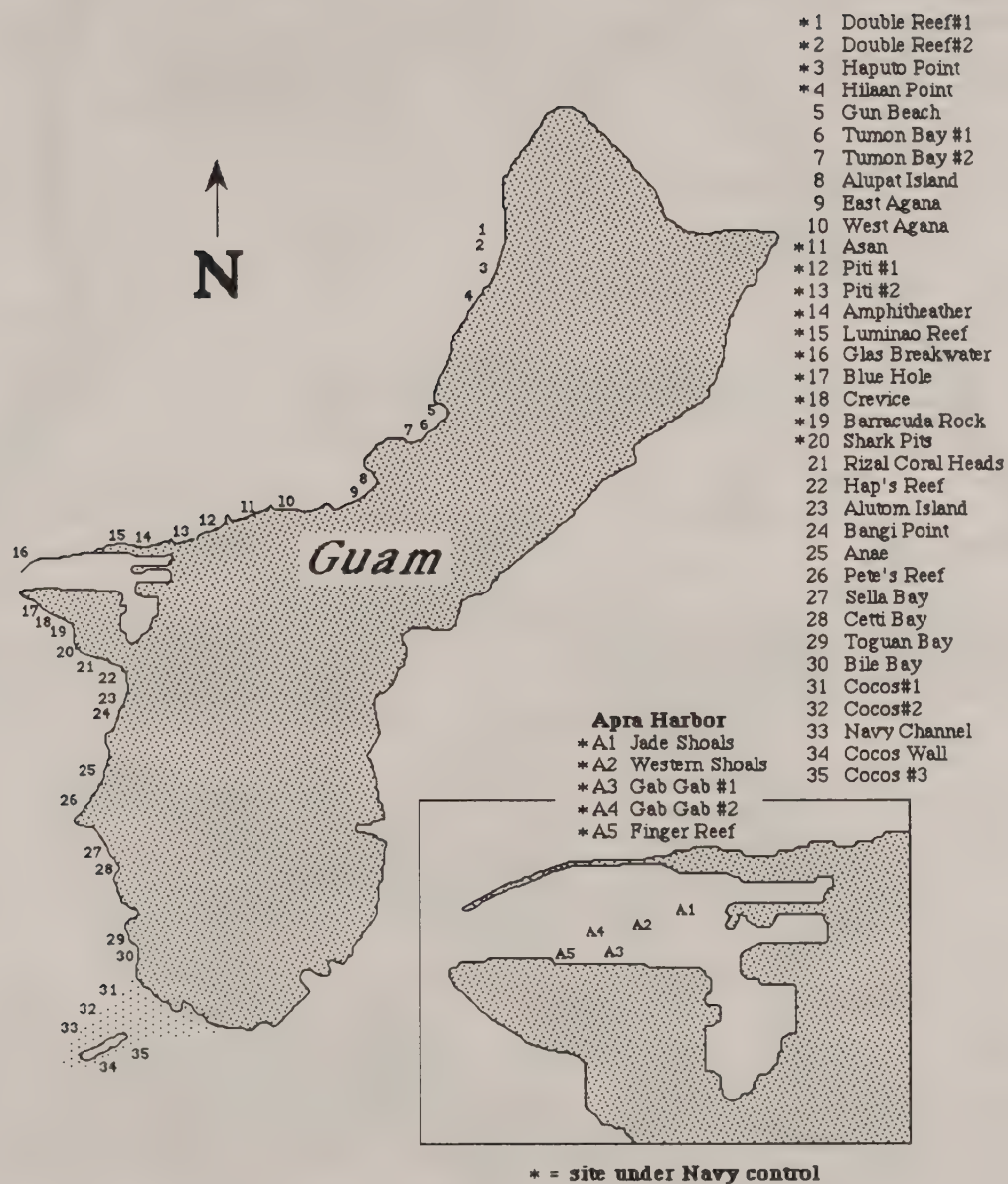


Figure 1. Shallow Water Mooring Sites

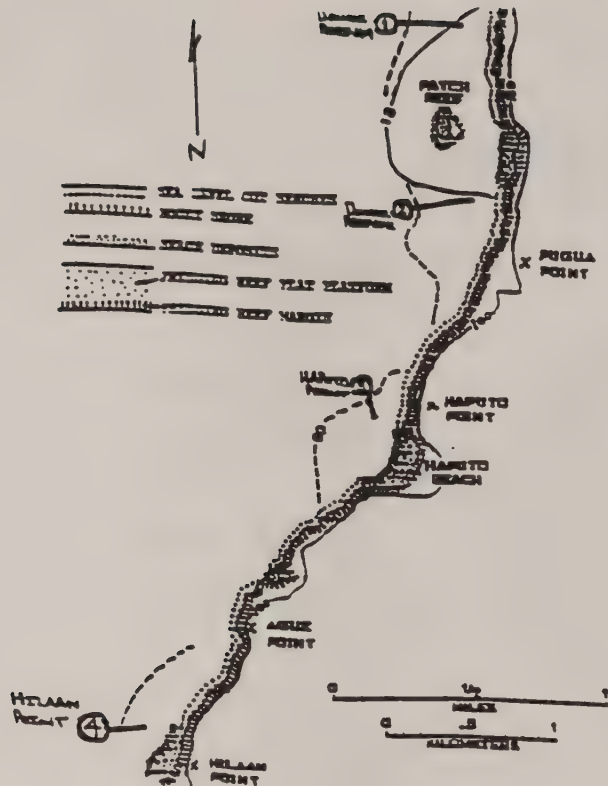


Figure 2. Sites 1-4. Map showing the 100 ft coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft (solid line) and 60 ft (dashed line) submarine contour lines.

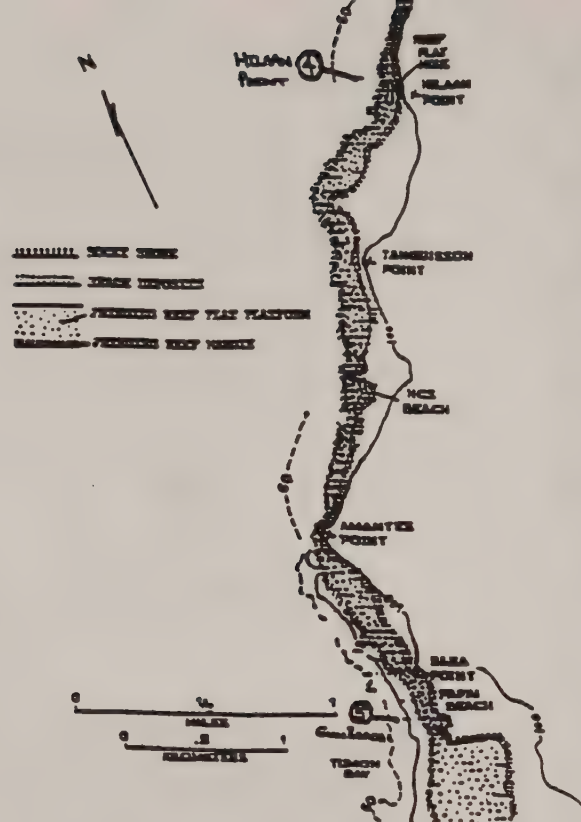


Figure 3. Sites 4-5. Map showing the 100 ft coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft (solid line) and 60 ft (dashed line) submarine contour lines.

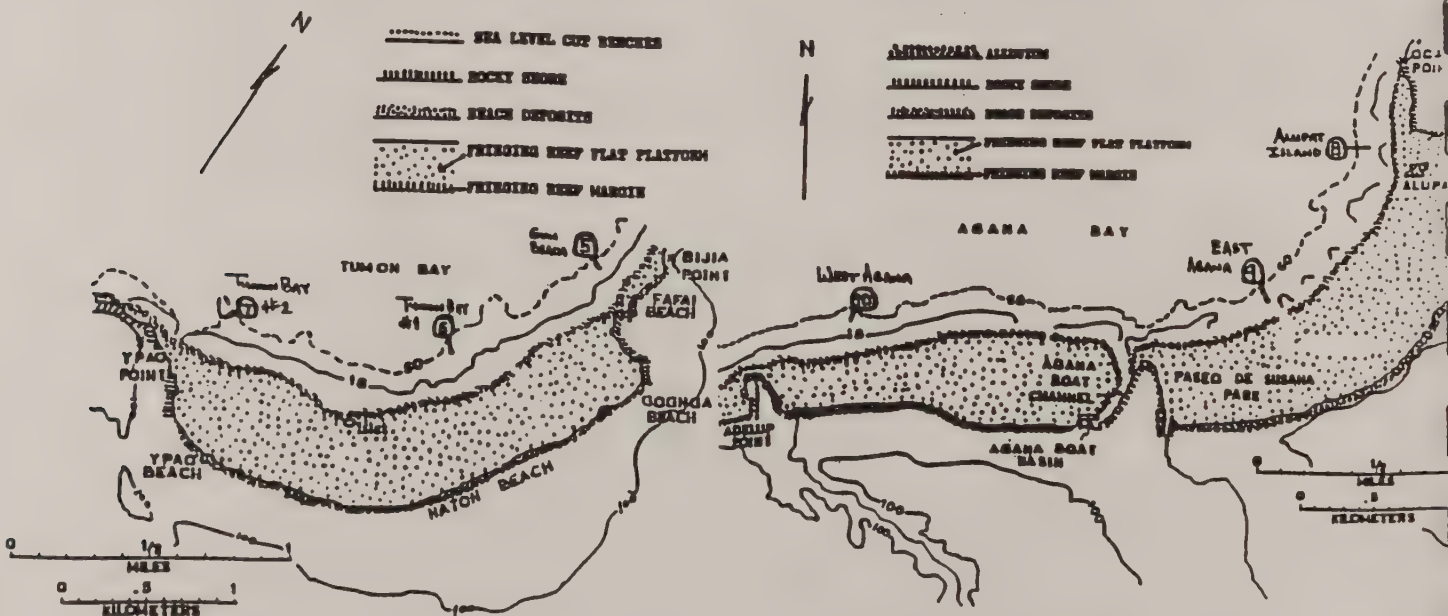


Figure 4. Sites 5-7. Map showing the 100 ft coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft (solid line) and 60 ft (dashed line) submarine contour lines.

Figure 5. Sites 8-10. Map showing the 100 ft coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft (solid line) and 60 ft (dashed line) submarine contour lines.

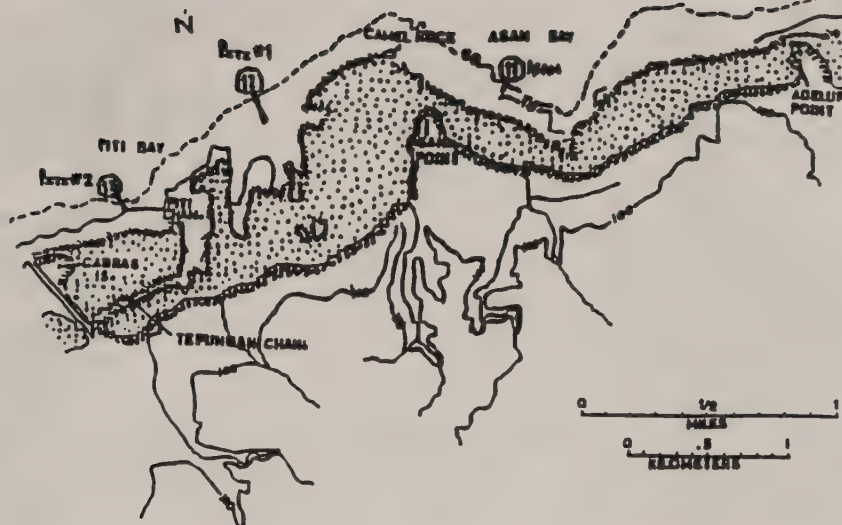




Figure 8. Sites 21-26. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

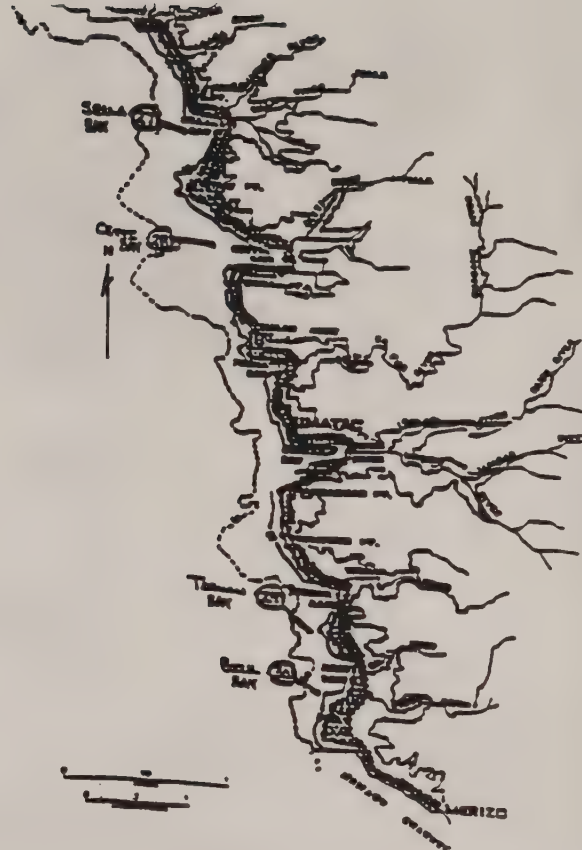


Figure 9. Sites 27-30. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

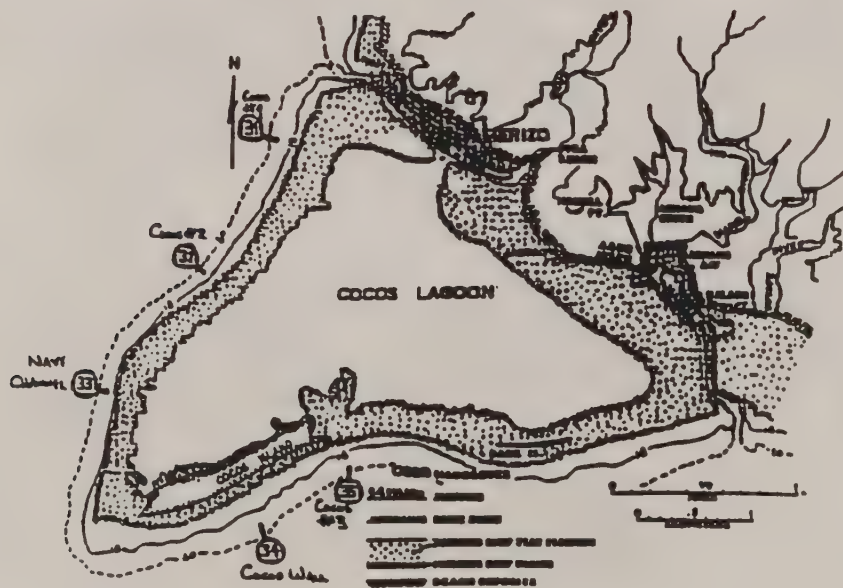


Figure 10. Sites 31-35. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

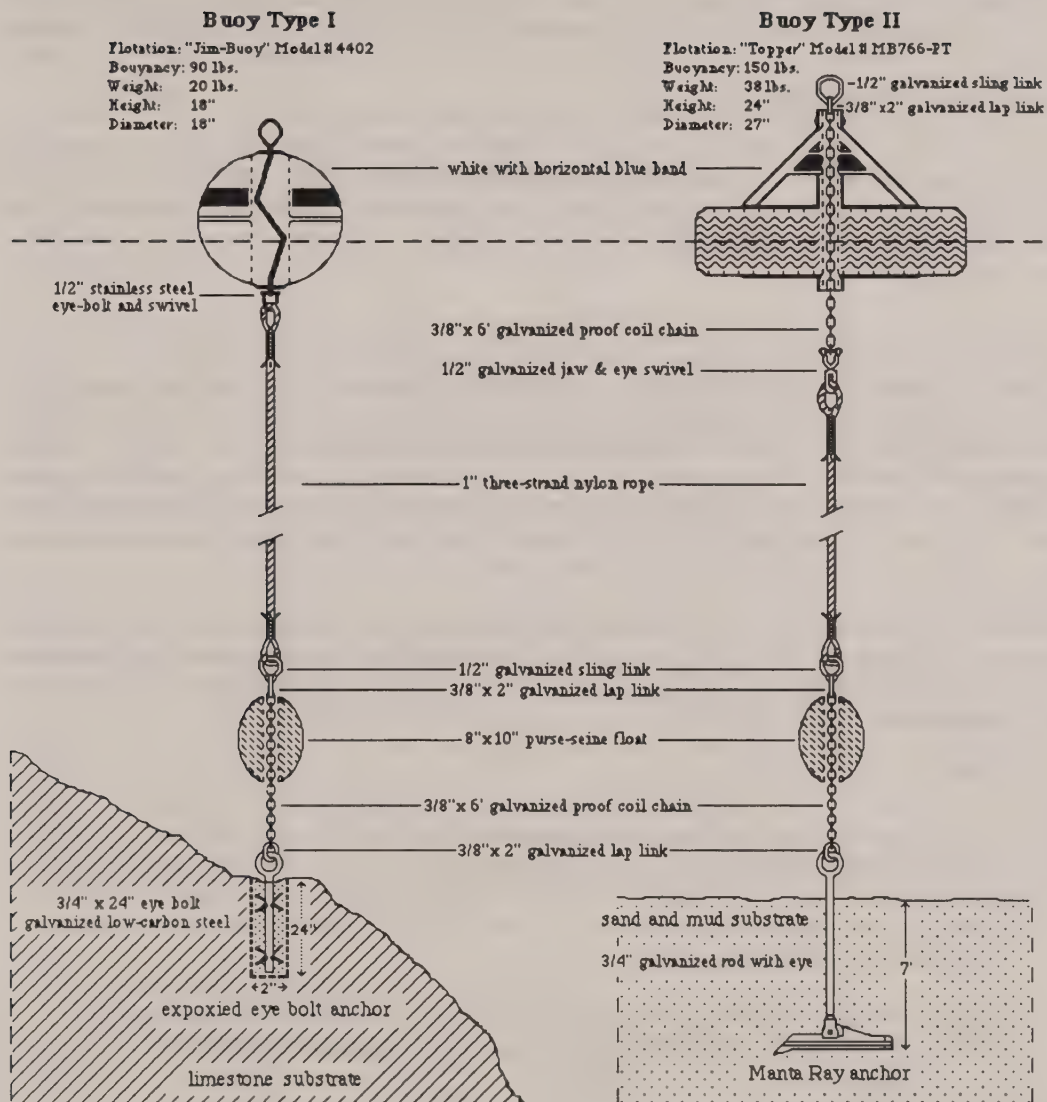


Figure 11. Shallow Water Mooring Designs

feet deep. The application and review process was completed in FY98 and DAWR received GSPC Seashore Clearance on March 27, 1998.

As required by the ACOE permit, DAWR submitted a request on July 7, 1997 to the Commander U.S. Naval Forces, Marianas, for authorization to install SWMs at 19 sites located on submerged Navy property. Approval for 14 of the 19 sites was finally granted on March 30, 1998. Sites 3, 16, 18, 19 and A5 were not authorized due to Navy safety and operational considerations.

After receiving approval for the majority of the requested sites on Navy submerged property, the permitting process was essentially completed by April 1998. Thus, installation of the SWMs could begin once the necessary installation equipment and materials were purchased and received, and a contractor selected to conduct the initial installation procedures.

Original plans also included training of DAWR staff on the use of the equipment and proper installation procedures so that future installations could be handled in-house. However, the concern was raised that only professional commercial divers could conduct this type of work according to OSHA regulations. Because of this, a Request for Proposals (RFP) was issued on July 1, 1998 for commercial dive services and a vessel to serve as a work platform for the SWM installation procedures. The need to go through the RFP process resulted in a further delay in getting the project underway before the end of September 1998. The contracts for commercial dive services and the work vessel are expected to be finalized during FY99. The SWM installations will occur in FY99.

Purchase and receipt of ropes, chains and miscellaneous hardware to assemble the SWM systems was completed in FY97. Purchase of the hydraulic installation equipment and other required materials was made in May 1998. Receipt of the equipment and materials was completed by August 1998.

RECOMMENDATIONS

The project to develop and enhance the Guam SWM program under F-2-D-11 should be continued with the following recommendation for FY99:

1. Complete contract negotiations for commercial dive services and work-boat by the end of November, 1998.
2. Begin installation of SWMs by mid to late-December; complete installations within 90 days of the start date if weather and sea conditions permit.

PROGRAM COST

The FY98 estimated cost for the SWM project is \$42,306.

This report was prepared by: Andrew A. Torres.

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-3-D
SEGMENT: 2

PROJECT TITLE: Maintenance and Redeployment of DAWR FADs and SWMs (2323)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

FADs

The coordinates of the sixteen operational sites in the Division of Aquatic & Wildlife Resources' (DAWR) Fish Aggregating Device (FAD) program and their relative locations to the island are depicted in Figure 1. As of September 30, 1998, the Facpi 2 site was the only one missing a buoy; which was reported off-station on the 14th of September and recovered the following day. Figure 2 diagrams the design and construction of the FAD system presently being used at each of the sites.

The average time on station for the FADs lost in FY98 was approximately 11 months, roughly a 7-month decrease from the FY97 average of around 18 months. The decrease in the average lifespan is largely the result of the Fadian, Agat and Facpi 2 FAD losses after being on site for less than 3 months. Of the three, the Agat and Facpi 2 losses are believed to be the result of fish-bite given the appearance of the break on the line and the depth at which the break occurred (the line on the Fadian FAD had already been removed before it was recovered and therefore the cause of the loss could not be determined). If these three FAD losses were not included in the calculation of the average time on station (because they did not exceed the critical 6-month initial time on site), the resulting recalculation would yield a figure just over the expected lifespan of 24 months. Table 1 lists the five FADs lost in FY98, the date last deployed, when they were reported to be off-station, recovery date and length of time on station.

Table 1. FAD Losses - FY98

Site	Date Deployed	Date Lost	Date Recovered	Time on Site
Fadian	09/05/97	12/15/97	01/08/98	3 months
No. 2	07/15/94	12/16/98	not recovered	3 yrs, 5 mos
No. 5	06/23/97	02/20/98	02/20/98	8 months
Agat	07/14/98	07/25/98	07/28/98	2 weeks
Facpi 2	07/15/98	09/14/98	09/15/98	2 months
Average:				11 months

The average replacement period for a FAD system in FY98 was 3-1/3 months with a range from 1 day to 8-1/2 months. How quickly a FAD can be reestablished depends primarily on prevailing sea conditions because deployments are typically conducted during calm seas to ensure the safest working conditions. Therefore, the 8-1/2 months that it took to replace the Fadian FAD was greatly affected by the fact that this site is located on the windward side of the island where there are much fewer periods of calm seas to work with. Table 2

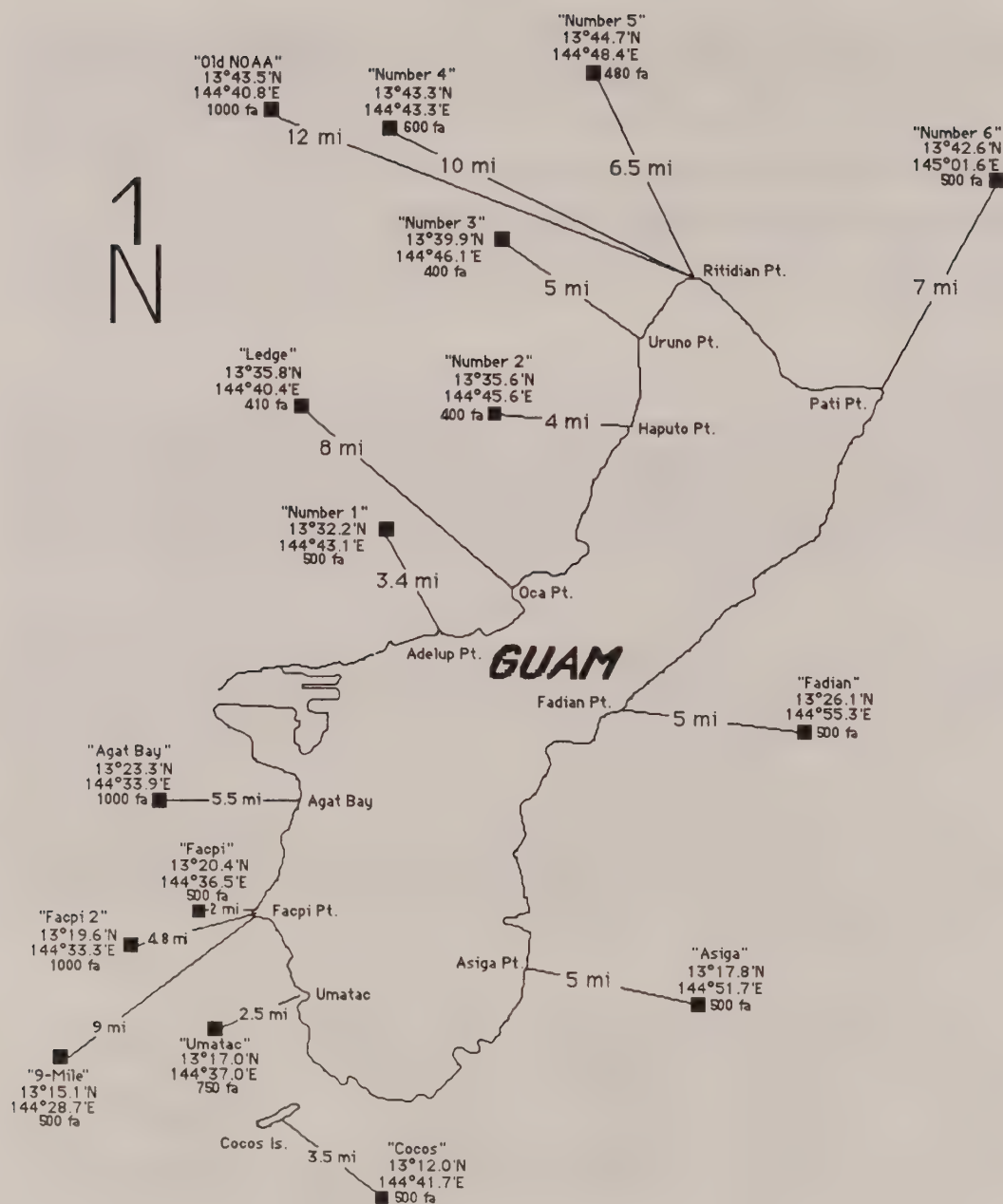


Figure 1. DAWR FAD Sites

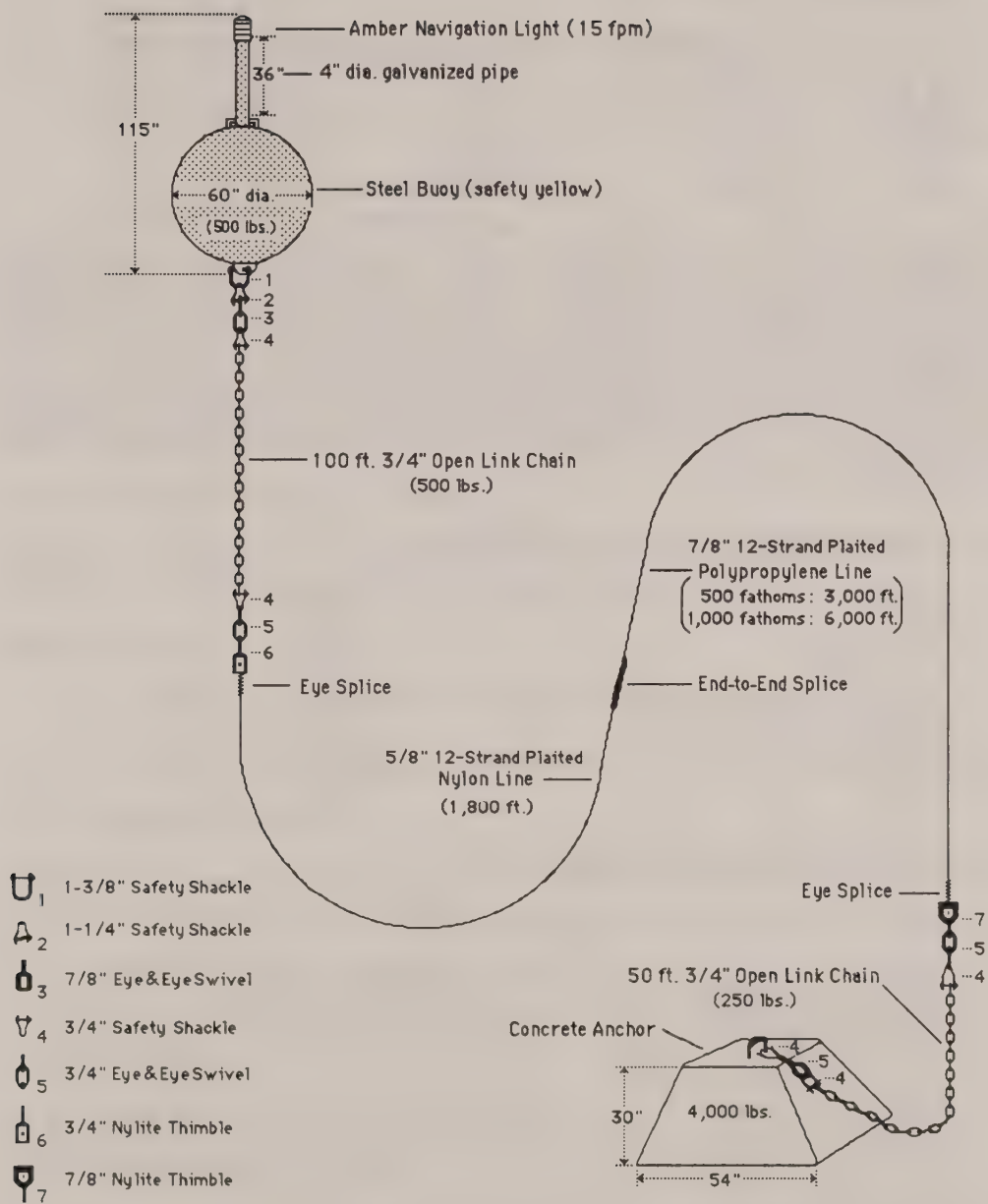


Figure 2. FAD with Spherical Steel Buoy

lists the location, redeployment dates and replacement time for the five FADs that were reestablished in FY98.

Table 2. Reestablished FADs - FY98

<u>Site</u>	<u>Date Reestablished</u>	<u>Date Recorded Lost</u>	<u>Replacement Period</u>
No. 4	10/05/97	08/08/97	2 months
No. 2	02/26/98	12/16/97	2-1/2 months
No. 5	07/01/98	02/20/98	3-1/2 months
Agat	07/29/98	07/28/98	1 day
Fadian	09/04/98	12/15/97	8-1/2 months
Average:			3-1/3 months

The average replacement costs for a 500-fathom FAD system for FY98 was \$8,992.39; up nearly \$1,200.00 from the previous year. This was the result of a majority of the replacements being located the furthest away from the port, and the additional stops made to replace lights of operational FADs in the area on the return trips. Table 3 lists the major costs for the replacement of a 500-fathom FAD system. A 1,000-fathom FAD system costs an extra \$1,770.00 due to the additional 3,000 feet of polypropylene rope necessary to complete the system. Table 4 provides a summary of recovery and buoy and light replacement activity for FY98.

Table 3. Average Replacement Cost per 500-Fathom FAD System - FY98

<u>Item/Service</u>	<u>Cost</u>
Buoy	\$518.50
Buoy Preparation*	\$494.00
Anchor Block	\$368.96
Mooring System (500 fathoms)**	\$4,138.90
Navigation Light and Batteries	\$242.93
<u>Loading and Deployment</u>	<u>\$3,229.10</u>
Total:	\$8,992.39

* Includes sanding, painting, welding and moving services.

** Additional \$1,770.00 for 1000-fathom system

Table 4. Operations & Maintenance Activity and Costs - FY98

<u>Activity</u>	<u>Date</u>	<u>Cost</u>
Reestablish No 4 FAD; replace lights: Nos. 5-6 (scheduled 09/30/97; FY97 P.O.)	10/05/97	\$11,755.00
Recovery of Fadian FAD off Inarajan shoreline	01/08/98	\$200.00
Recovery of No.5 FAD off Two-Lovers Point.	02/20/98	\$1,684.00
Reestablish No.2 FAD; replace lights: Nos.1,3,4 & Old NOAA	02/26/98	\$12,279.50
Replace lights: Facpi, 9-mile, Umatac, Cocos and Asiga	03/17/98	\$2,120.00
Miscellaneous painting and buoy refurbishment	Feb-Mar/98	\$572.50
Reestablish No.5 FAD; replace lights: Nos. 1-4, Ledge, Old NOAA	07/01/98	\$12,243.50
Replaced light: Facpi (after deployment of new Agat FAD)	07/14/98	--

Replaced lights: Nine-Mile and Umatac (after deployment of new Facpi 2 FAD)	07/15/98	--
Recovery of Agat FAD	07/28/98	\$1,331.00
Reestablish Agat FAD	07/29/98	\$13,110.00
Replaced light: No.6 (did not use Cabras Marine)	08/27/98	--
Reestablish Fadian FAD; replace lights: Asiga, Cocos	09/04/98	\$13,185.00
Recovery of Facpi 2 FAD	09/15/98	\$1,331.00
Total:		\$69,811.50*

*Does not include personnel cost and benefits

DAWR has further streamlined the predeployment preparation of FAD systems by ordering prespliced 500- and 1000-fathom systems according to DAWR specifications. The prespliced lines add little to the total cost of the FAD system, however save considerable manpower time and further facilitate convenient short-notice replacements of lost FADs. An example of this was the replacement of the Agat FAD only one day after it was recovered by using a prespliced 1,000-fathom system right out of the original shipping carton. Given the initial success of this approach on at least four separate occasions, future orders of FAD lines will consist primarily of prespliced systems

Shallow Water Moorings (SWMs)

There was no maintenance or replacement activity recorded for the SWM project in FY98. Installation of SWMs is expected to begin sometime in early FY99.

OBJECTIVES

1. To maintain, preserve and efficiently replace DAWR's fish aggregating devices.
2. To maintain, preserve and efficiently replace DAWR's shallow water moorings.

RECOMMENDATIONS

The project to maintain and reinstall FADs and SWMs should be continued with the following recommendations for FY99:

1. Reestablish the open account to prepare FAD systems for deployment, conduct actual deployments, recover errant buoys, and perform on-site replacement of expired navigation lights and worn FAD buoys on an as-is-needed basis.
2. Identify and contract a private vendor to conduct SWM maintenance and reinstallation services on a short notice and as-is-needed basis similar to that of the FAD project.
3. Reorder buoys, concrete anchors, pre-spliced ropes, chains and other miscellaneous mooring hardware to establish an inventory sufficient to replace up to ten 500-fathom FAD systems and twenty 10-fathom SWM systems.
4. Purchase a new work-boat to allow for some minor maintenance routines to be conducted for both the FAD and SWM projects.

5. Establish and maintain an inventory of other miscellaneous equipment, supplies and materials, such as navigation lights and batteries, necessary for both the FAD and SWM projects.

PROGRAM COST

The estimated cost for the project to continue maintenance and reinstallation of FADs and SWMs is \$69,812.

Prepared by: Andrew A. Torres

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-4-D
SEGMENT: 1

PROJECT TITLE: Marine Fish Habitat Improvement and Aggregating Devices (2323)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Fish aggregating device (FAD) development activity under Project F-4-D focuses primarily on identification and survey of potential new sites including the initial deployment of FAD systems. The project also involves enhancement projects such as the production of FAD location maps for fishers and the improvement of the current FAD system design to extend the average time on station. Table 1 provides a chronological listing of the major activities recorded under F-4-D-1 and a cost estimate for each activity excluding personnel costs and benefits. Maintenance procedures, modifications, recoveries, redeployments, and material procurement for FY98 were conducted under F-3-D-2: Maintenance and Redeployment of Fish Aggregating Devices and Shallow Water Moorings.

Table 1. DAWR FAD Program Development Activity - FY98

<u>Activity</u>	<u>Date</u>	<u>Cost</u>
Bottom contour surveys: Ledge & Old NOAA (FY97 P.O.)	09/26/97	(\$1,200.00)
Bottom contour surveys: Agat & Facpi 2 (FY97 P.O.)	10/09/98	(\$1,200.00)
Establish Old NOAA FAD	10/11/97	\$11,000.00
Establish Ledge FAD	11/26/98	\$11,500.00
Establish Agat FAD	07/14/98	\$13,300.00
Establish Facpi 2 FAD	07/15/98	\$13,950.00
Total:		\$49,750.00*

* Does not include personnel costs and benefits

The number of operational sites in the Guam DAWR FAD program increased from 12 to 16 in FY98 with the deployment of the "Old NOAA" FAD on November 11, 1997, the "Ledge" FAD on the 26th of the same month, the "Agat" FAD on July 14, 1998 and the "Facpi 2" FAD the following day. Figure 1 approximates the location of each of the operational FADs relative to the island.

The recommendation to use the Indian Ocean "raft" as an economical, low-resistance and easily maintained alternative buoy system was tabled again in FY98 and will remain so until DAWR can obtain an Coast Guard exemption from having to install navigation lights on this particular FAD buoy design. The basis for the exemption is that the string of purse seine floats forming the raft poses little threat should a vessel collide into such a system. As depicted in Figure 2, the Indian Ocean raft system uses a flag to mark the location of the FAD. Present Coast Guard regulations requiring the installation of a navigation light would necessitate further modification of the raft to include another buoy on the terminal

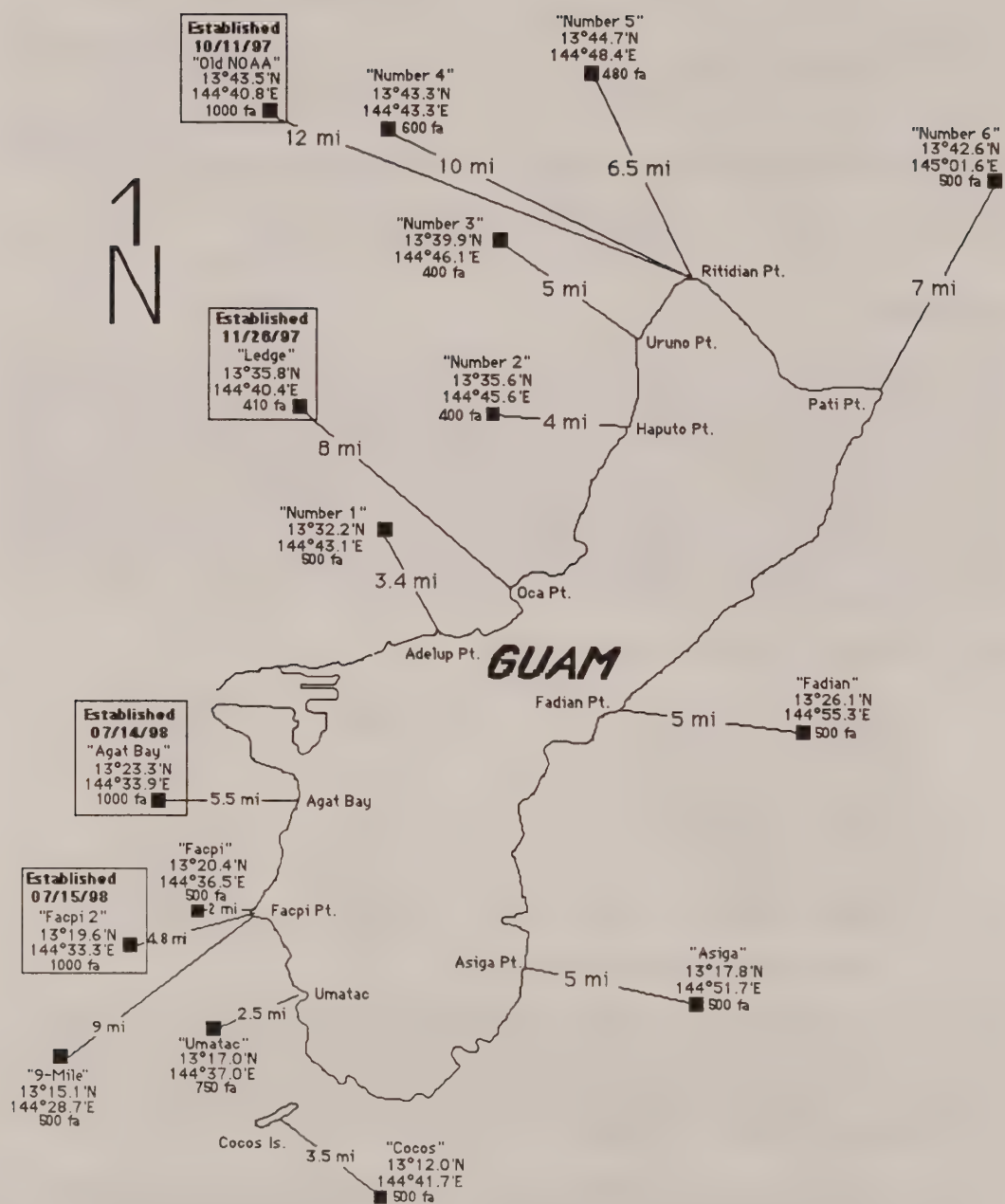


Figure 1. DAWR FAD Sites

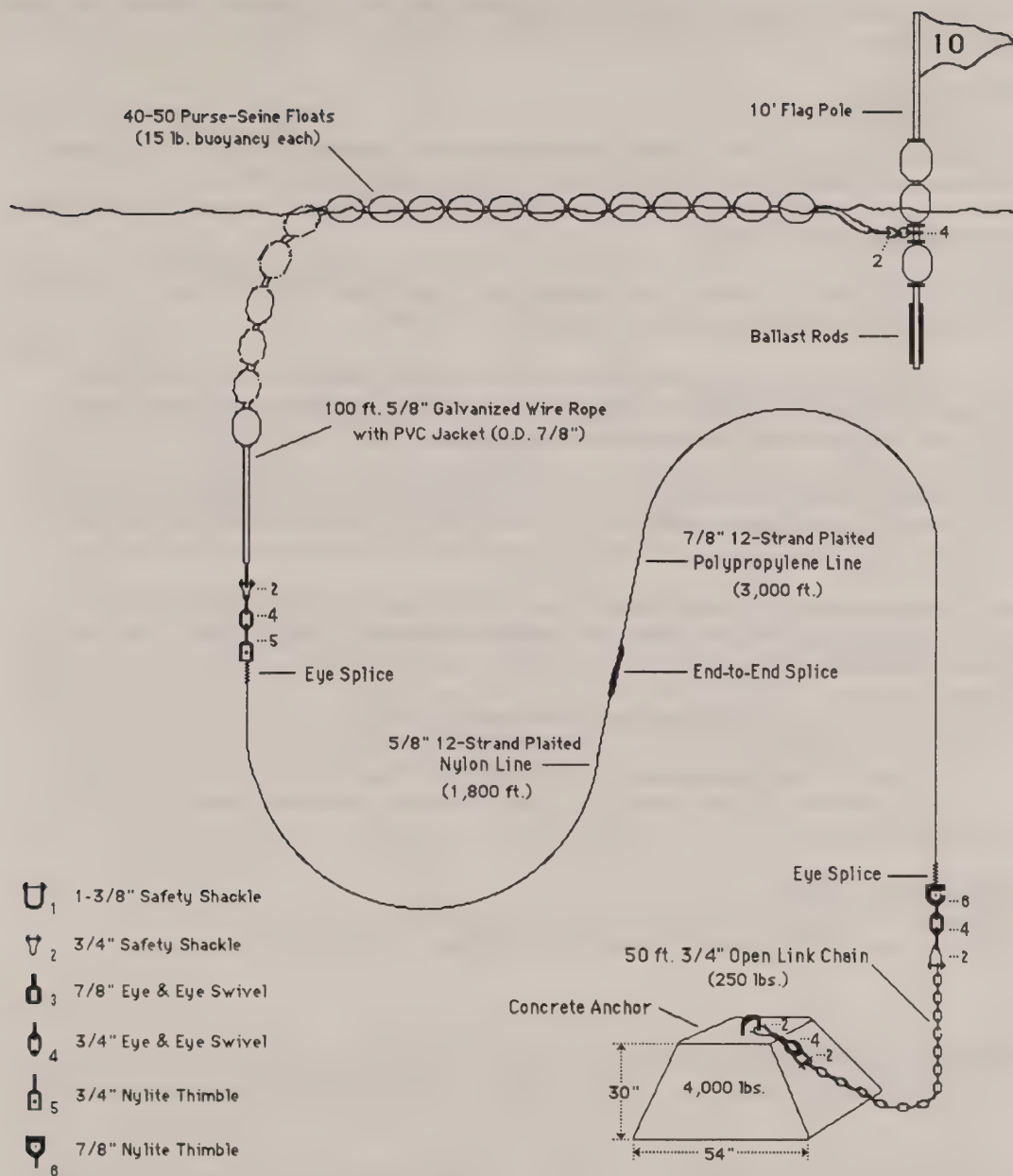


Figure 2. FAD with Indian Ocean Raft Buoy

end of the buoy system to support a navigation light with 8 lantern batteries weighing nearly 20 pounds.

OBJECTIVE

To enhance access to Guam's heavily utilized nearshore pelagic fishing grounds through the continued development of a system of fish aggregating devices (FADs).

RECOMMENDATIONS

The F-4-D project to develop and enhance the Guam DAWR FAD program should be continued with the following recommendations for FY98:

1. Continue pursuit of program enhancement activities such as identification and permitting of potential new sites, and production of laminated FAD site maps and route planners for distribution to fishers.
2. Attach ribbons made of plastic strapping material to upper mooring chain of each FAD to further enhance bait and fish-holding characteristics of the FADs.
3. Obtain exemption from Coast Guard of navigation light requirement for Indian Ocean raft buoy and then begin experimental use of this design at several sites.
4. Develop a practical form of cut protection for the upper 1,000 feet of nylon line, or incorporate a more cut-resistant line in the mooring system to replace the type of nylon line presently being used, given that most breaks continue to occur between 101 feet (where the upper mooring chain ends) down to about 750 feet.

PROGRAM COST

The estimated cost for the FAD project is \$49,750.

Prepared by: Andrew A. Torres

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: CVA-1

JOB TITLE: Construction of Pumpout Facilities

PERIOD COVERED: October 1, 1997 - September 30, 1998

SUMMARY

In 1997, the Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR) was awarded a \$107,000 three-year grant through the Clean Vessel Act Pumpout Grant Program. DAWR conducted an assessment of the pumpout facility (POF) needs and identified two locations to install pumpout stations (POS), which included: The Gregorio Perez Marina in Agana; and the Agat Marina in Agat. These locations were determined to have the highest boat vessel traffic as the highest priority locations for POFs.

Various companies specializing in POFs were contacted for information on different systems and prices. The Guam Port Authority and Guam Waterworks Authority were contacted to assist in the planning and contract phases. DAWR staff inspected the marinas, to find possible locations for a stationary POS for each site. DAWR is currently working with the Port Authority to determine the best POS for each of the marinas.

OBJECTIVE

1. To construct POFs, which will provide recreational boaters with facilities to dispose of their sewage.
2. To develop a boater education program to increase environmental awareness of the negative aspects of direct discharge of waste into the ocean.

PROCEDURE

A feasibility study was done to identify all operational POS available in Guam, determine recreational vessels with holding tanks or portable toilets, and identify all potential sites in order to ensure adequate and reasonable availability.

Memos were sent to the General Manager of the Port Authority of Guam (PAG) and General Manager of the Guam Waterworks Authority (GWA) to request their assistance and involvement in the planning and construction processes. The Port Authority met with staff in October to discuss suitable locations at the marinas for installation of POFs and to appoint a contact person. The PAG manages all the marinas on Guam and would therefore be in charge of the operation and maintenance of the POFs. The GWA was contacted requesting their permission to incorporate the POS into the main sewer lines at both marinas and also to appoint a contact person.

RESULTS

After speaking to the Port Authority and Coast Guard, it was determined that there are no established POFs available on Guam. The two marinas were inspected to determine potential sites for POFs that would be easily accessed and most convenient to boaters. From initial observations, the best sites determined for accessibility and convenience are those adjacent to the gas pumps at both marinas.

The meeting between the Port Authority and DAWR resulted in a positive agreement that POS are necessary at the two marinas. DAWR is awaiting a response from the Port Authority concerning their recommendations for the construction of the POS.

A draft scope was completed for use in bid for the design and construction of the POS.

During Safe Boating Week in May, a presentation board explaining the benefits of POS, the detrimental effects of sewage dumped from boats, and the Clean Vessel Act was displayed for the community to view at the U.S. Coast Guard and Coast Guard Auxiliary's exhibition at the Agana Shopping Center. Flyers were also available and distributed to all interested persons.

RECOMMENDATIONS

To expedite the construction of the POS, the following recommendations are submitted for FY99:

- 1) Resolve negotiations with the Port Authority to determine the most feasible POS and best sites for this system.
- 2) Submit bid package.

PROGRAM COST

The estimated cost for the POF project is \$100.00.

Report Prepared by Veronica Cummings

GUAM COMMERCIAL FISHERIES

STATE: Territory of Guam

JOB TITLE: Commercial Fisheries on Guam

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Commercial fisheries receipt books were used by five vendors during the fiscal year. The collected data was computerized and sent to NMFS in Hawaii.

BACKGROUND

The commercial fisheries program was established in 1979 to learn more about the fishery resource being caught and sold on Guam. The program was initiated by the National Marine Fisheries Service (NMFS). In the beginning, data was only collected from the Guam Fishermen's Cooperative in Agana, Guam. The program has slowly grown over time with many of the early participants no longer in business. As part of the long-term program plan, data collection and management has shifted from NMFS in Hawaii to the Guam Division of Aquatic and Wildlife Resources (DAWR). Program responsibility has slowly increased to the point where DAWR now handles data collection, computer input and production of commercial landing tables. All data collected is forwarded to NMFS for further analysis by their staff for regional reports.

OBJECTIVES

To monitor, analyze and report locally caught fish sales and related activities through the collection of vendor receipts.

PROCEDURES

The Guam Commercial Fisheries receipt books are provided to each volunteer fish vendor. When the catch is purchased, each cooperating vendor is asked to record the following information: name of the person, date, hours fished, number of fishermen, fishing location and fishing method. The assigned fisherman number is placed on each receipt after it is returned. A record is kept of all new people who sell fish and when they have consistently sold fish are given a number. The catch information is broken down into six primary areas:

- 1) Bottom fish
- 2) Reef fish
- 3) Troll (pelagic) fish
- 4) Invertebrates
- 5) Seaweed
- 6) Imported Items.

Each category of organisms has an assigned code number. Although there is a category for imported fish, the program is primarily intended to monitor locally caught and sold fish. There is space provided to indicate the number of items sold, total weight, price paid per pound, the value of the items, the total value of the transaction and any additional remarks. There are three copies of each receipt with one for the person selling the catch, the vendor and one for DAWR. Vendors are visited on a regular basis to monitor completion of the forms, collect completed receipt books, to check on errors and insure they have a supply of receipt books.

RESULTS

During FY98, vendor receipt books were collected from five active cooperating vendors on a regular basis. The collected data was entered, cross-checked for accuracy and all questions about the data verified with the vendors. Data representing the actual sold catch from the program for the fiscal year has been transferred to the NMFS office in Hawaii for storage, inclusion in the "Fishery Statistics of the Western Pacific" and the bottom fish and pelagic plan monitoring team annual reports.

RECOMMENDATION

Develop regulations to require the person representing the catch to provide an identification number to each vendor when selling locally caught and imported fish. This would give a more comprehensive view of the commercial fishery activity around Guam.

Report prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1-R-6
SUBPROJECT NO.: W-1
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Determination of Current Population Size and Distribution of Guam Deer
(1460)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Official logs with deer harvest statistics for Andersen Air Force Base (AAFB) were examined and revealed a total of 3,481 hunter sorties, a harvest of 87 deer, and a harvest rate of one deer per 40.0 hunter-days. Population trend data obtained with spotlight counts at Pati Point, AAFB showed a significant increase ($P < 0.001$) in deer numbers, with an average of 13.5 animals recorded per km during counts. On Naval Ordnance Annex (NOA) spotlight counts revealed a non-significant increase ($P > 0.05$) in deer numbers, from 1.9 animals recorded per km in FY97 to 2.4 in FY98. Spotlight counts were expanded to the Munitions Storage Area (MSA; formerly the Conventional Weapons Storage Area) on AAFB. Revision of Guam's existing deer hunting regulations are ongoing in an attempt to increase deer take and reduce extensive habitat damage, especially on military lands.

BACKGROUND

The Guam deer (*Cervus mariannus*), or Philippine deer, has been under investigation by the Division of Aquatic and Wildlife Resources (DAWR) since 1961 (DAWR 1961-1997). Preliminary information on distribution, population trends, and biology appeared in Wheeler (1979). Deer hunting statistics have been compiled annually since 1968. Guam has a split deer hunting season, running from October 1 to December 31 and from September 1-30. There is a bag limit of one antlered deer per season per license holder exclusive of any special harvest.

OBJECTIVES

To determine the current size and distribution of the deer population on Guam and to monitor population trends.

PROCEDURES

1. Conduct monthly spotlight counts on AAFB and NOA, and periodic counts elsewhere on the island.
 - a. Record number, sex, age, and group composition.
 - b. Analyze count data and compare with previous data to discern population trends.
2. Monitor hunter participation and harvest during the legal hunting season.

3. Collect biological data from animals killed during the hunting season and from incidental sources such as road kills or confiscated animals.

RESULTS

Deer Hunting Statistics

Records of hunting activity and harvest were kept by officials at AAFB during the deer hunting season (Table 1). According to hunter logs from AAFB, 1,647 hunter-days (2777 sorties; gun hunting only) were expended at Northwest Field (NWF) and resulted in the harvest of 82 deer. At Andersen South, 15 hunter-days (52 sorties; bow hunting only) were registered, with no deer taken. Hunting areas on the main portion of the base (MSA, Tarague basin, near the landfill, and areas north and east of the flight-line) recorded 483 hunter-days (652 sorties; primarily bow hunting), with five deer harvested. The Naval Computer and Telecommunications Area Master Station (NCTAMS) was closed to all hunting this year.

Table 1. Hunter effort and deer taken on AAFB during FY98, based on official hunter logs.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Andersen Air Force Base													
<u>Northwest Field</u> (gun hunting only)													
No. hunter sorties	741	657	547									832	2777
No. hunter days (8 hr)	456	395	313									483	1647
Deer taken	19	19	25									19	82
Days effort/take	24.0	20.8	12.5									25.4	20.1
<u>Main Base</u> (primarily bow hunting)													
No. hunter sorties	247	292	113									344	652
No. hunter days (8 hr)	99	129	49									152	429
Deer taken	0	3	0									2	5
Days effort/take	—	43.0	—									76.0	85.8
<u>Andersen South</u> (bow hunting only)													
No. hunter sorties	25	27	0									0	52
No. hunter days (8 hr)	7	8	0									0	15
Deer taken	0	0	0									0	0
Days effort/take	—	—	—									—	—

Hunter questionnaires were discontinued in FY96 because of a lack of manpower and low return rates in previous years, which may have resulted in biased sampling of the hunter community. Proposed revised hunting regulations may remedy this problem by requiring hunters to complete the questionnaire prior to license purchase.

Spotlight Count Trends

Spotlight counts at Pati Point showed that deer numbers significantly increased this year (Mann Whitney *U*-Test, $U' = 54$, $n_1 = 6$, $n_2 = 9$, $P < 0.001$) from FY97. The average number of deer seen per count increased from 63.2 (9.6 deer/km) in FY97 to 87.3 (13.5 deer/km) in FY98 (Table 2). The largest single nightly count on AAFB increased from 73 deer in FY97 to 97 deer in FY98.

Table 2. Composition of deer seen during spotlight counts at Pati Point on AAFB, FY98.

Class	----- 1997 -----			----- 1998 -----										Total	Mean	SD
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep				
Unclassed buck	6	5		5		0	2		1	0	1	0	20	2.2	2.4	
Spike	2	2		4		5	3		3	4	2	2	27	3.0	1.1	
2 pt	10	5		3		7	2		0	8	2	3	40	4.4	3.3	
3 pt	11	6		12		6	5		3	4	8	6	61	6.8	3.0	
4 pt	0	1		0		0	0		0	0	0	0	1	0.1	0.3	
Doe	37	35		35		42	43		31	37	38	36	334	37.0	3.7	
Yearling	6	7		6		9	7		12	16	16	16	95	10.6	4.5	
Fawn	2	4		3		9	1		2	4	7	7	39	4.3	2.7	
Unclassed deer	18	23		13		9	19		40	24	10	13	169	18.8	9.6	
Total deer	92	88	nc	81	nc	87	82	nc	92	97	84	83	786	87.3	5.4	
Miles traveled	3.9	4.4		4.0		4.0	4.0		4.2	4.0	4.0	4.0	36.5	4.1	0.2	
Km traveled	6.4	7.1		6.4		6.4	6.4		6.8	6.4	6.4	6.4	58.6	6.5	0.3	
Deer/mi	23.6	20.0		20.3		21.8	20.5		21.9	24.3	21.0	20.8	194.2	21.6	1.5	
Deer/km	14.6	12.4		12.7		14.5	12.8		13.5	15.2	13.1	13.0	121.8	13.5	1.0	

nc = no count was made.

Spotlight counts in the MSA were initiated in October due to the large deer numbers and heavy vegetation damage seen in the area. The October count used two spotlights and a total of 267 deer were seen along the 22.5-km route. Deer were surveyed with one spotlight for the remainder of the year (Table 3). The average number of deer seen per count, excluding the October count, was 123.8 (8.2 deer/km).

Table 3. Composition of deer seen during spotlight counts in the Munitions Storage Area on AAFB, FY98.

Class	----- 1997 -----			----- 1998 -----										Total	Mean	SD
	Oct*	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep				
Unclassed buck		6				4	4		5	1			20	4.0	1.7	
Spike		2				4	3		1	2			12	2.4	1.0	
2 pt		9				2	2		0	5			18	3.6	3.1	
3 pt		4				5	7		2	1			19	3.8	2.1	
4 pt		0				0	0		0	0			0	0	0	
Doe		63				71	86		36	48			304	60.8	17.5	
Yearling		13				14	21		9	18			75	15.0	4.1	
Fawn		11				13	11		9	10			54	10.8	1.3	
Unclassed deer		50				28	35		24	28			165	33.0	9.2	
Total deer		158	nc	nc	nc	141	169	nc	86	113	nc	nc	667	133.4	30.3	
Miles traveled		9.8				14.2	14		6.6	7.6			52.2	13.4	3.2	
Km traveled		15.8				22.9	22.5		10.6	12.3			84.1	16.8	5.1	
Deer/mi		16.1				9.9	12.1		13.0	14.9			66.0	13.2	2.2	
Deer/km		10.0				6.2	7.5		8.1	9.2			41.0	8.2	1.3	

nc = no count was made

* two spotlights were used (see text)

On NOA, deer numbers showed a non-significant increase (Mann Whitney *U*-Test, $U' = 27$, $n_1 = 5$, $n_2 = 8$, $P > 0.05$) in FY98 (Table 4) from FY97. The average number of deer

recorded per count climbed from 44.8 animals (1.9 deer/km) in FY97 to 52.0 animals (2.4 deer/km) in FY98 (Table 4). The largest single nightly count increased from 52 deer in FY97 to 91 deer in FY98.

Table 4. Composition of deer seen during spotlight counts an Ordnance Annex, FY98.

Class	----- 1997 -----			----- 1998 -----									Total	Mean	SD
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep			
Unclassed buck	3		3		6		3		0	4	2	4	25	3.1	1.7
Spike	2		1		4		0		2	1	3	1	14	1.8	1.3
2 pt	1		3		7		2		0	0	0	0	13	1.6	2.4
3 pt	0		3		7		1		3	3	8	1	26	3.3	2.9
4 pt	0		0		1		0		0	0	0	0	1	0.1	0.4
Doe	11		2		27		11		33	16	17	12	129	16.1	9.8
Yearling	2		4		2		5		7	8	6	10	44	5.5	2.8
Fawn	1		3		1		2		9	2	2	5	25	3.1	2.7
Unclassed deer	22		12		36		16		9	9	13	4	121	15.1	10.0
Total deer	42	nc	49	nc	91	nc	40	nc	63	43	51	37	416	52	17.7
Miles traveled	14.0		13.5		15.0		13.5		11.0	14.0	13.9	15.5	110.4	13.8	1.3
Km traveled	22.5		21.7		24.2		21.7		17.7	22.5	22.4	25.0	177.7	22.2	2.2
Deer/mi	3.0		3.6		6.1		3.0		5.7	3.1	3.7	2.4	30.6	3.8	1.3
Deer/km	1.9		2.3		3.8		1.8		3.6	1.9	2.3	1.5	19.1	2.4	0.9

nc = no count was made.

Depredation Permits

Twenty-two animal depredation permits were issued during this fiscal year. Of these, 11 permits were issued to farmers registered with the Guam Department of Agriculture. Nineteen permits authorized deer take in agricultural areas, while three permitted take in suburban areas. One permit authorized deer take on a military installation (AAFB). The requirement of a monthly report of deer take by permittees was initiated this year. Thirty-one deer were killed on AAFB, most of which came from control efforts inside Area 50. No deer were reported taken under other permits for non-military lands.

Hunting Regulations

New hunting regulations allowing unlimited year-round take of deer were proposed by the DAWR in FY98. Severe habitat damage in areas of moderate to high deer abundance prompted the proposal. A public hearing was held in June concerning the regulations. Field trips were subsequently held on AAFB to demonstrate the impact of deer on native vegetation. Officials from related agencies as well as a few members of the public attended the field trips. Oral and written testimony was collected and reviewed.

Because of public concern about over-harvesting in non-military parts of the island, the regulations were revised to reduce the take to three deer of either-sex per fiscal year, with the deer season reduced to a six-month period. These proposed hunting regulations will be submitted to the Twenty-fourth Guam Legislature for approval and will hopefully be enacted for the FY '00 hunting season.

Supertyphoon Paka / El Nino-Southern Oscillation

Supertyphoon Paka struck Guam on December 16-17 with estimated winds of 150-185 mph. The forests of central and northern Guam sustained extensive damage. The island subsequently experienced a severe dry season associated with an El Nino-Southern Oscillation event. Continued deer browsing magnified the habitat damage sustained from these two events. By July, many areas (i.e., MSA, Tarague basin, Pati Point, and Haputo) exhibited a lack of forest undergrowth. Many seedlings and saplings that survived Supertyphoon Paka were heavily browsed on. During the dry season, DAWR staff noticed greater than normal deer mortality on military lands. The increased fatalities may be related to a lack of food caused by heavy browsing pressure, general forest degradation brought on by Supertyphoon Paka, and the severe dry season.

RECOMMENDATIONS

Continue spotlight counts at present intensity at Pati Point and MSA on AAFB and on NOA. Expansion of spotlight counts to other areas is recommended. Biological data should be collected from carcasses whenever possible. Written guidelines concerning hunter logbooks should be given to the proper military personnel to ensure complete and accurate hunter participation records on military lands. Hunting on NCTAMS should be reopened. A comprehensive investigation into the movements and habitat use of these ungulates is needed. A study to examine the impacts of deer on native ecosystems remains a high priority.

PROGRAM COST

The estimated cost of the deer population and distribution project under W-1R-6 is \$32,000.

LITERATURE CITED

Division of Aquatic and Wildlife Resources. 1961-1997. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration. Guam Dept. Agric., Mangilao.

Wheeler, M. E. 1979. The biology of the Guam deer. Div. Aquatic Wildl. Resources Tech. Rept. No. 3, Mangilao, Guam. 53 pp.

Report prepared by: Dana T. Lujan

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-6
SUB-PROJECT NO.: W-1
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Population Size and Distribution of Wild Pigs on Guam (1460)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Examination of hunter logs for Andersen Air Force Base (AAFB) revealed a total of 4,786 hunter sorties, a harvest of 133 pigs, and a harvest rate of one pig per 19.4 hunter-days. An additional 88 pigs were removed from other areas of the base under a depredation permit. Hunter harvest data were not available for other parts of Guam.

BACKGROUND

Wild pigs (*Sus scrofa*) are Guam's most important game species in terms of total numbers of animals harvested. This species has been studied by the Division of Aquatic and Wildlife Resources (DAWR) since 1967 (Conry 1988, DAWR 1967-1997). The island's wild pig population is descended from domestic *S. scrofa* introduced by the Spanish from the Philippines between 1672 and 1685. Wild pigs are found island-wide, but appear to be most numerous in the secondary limestone forests of the north and the ravine forests of southern Guam. Pigs occur at high enough densities in many forested areas that rooting and wallowing damage is common and can be quite severe locally. Depredation on agricultural crops is also a problem, especially in southern Guam. About 20-30 animal depredation permits are issued annually to primarily control pig damage. Controlling the effects of pig damage is recognized as an important measure to protect native forest and agricultural resources. Recreational harvest is the primary tool used to control pig numbers and current hunting regulations allow for a year-round season with bag limits of 2 pigs per day and 40 per year. There is a need to consider more liberal regulations to control pig populations island-wide and in localized areas.

OBJECTIVES

To monitor trends in pig population size and hunter participation and harvest.

PROCEDURES

1. Monitor hunter participation and harvest during the legal hunting season.
2. Collect biological data from animals killed during the hunting season and from incidental sources such as road kills or confiscated animals.

RESULTS

Pig Hunting Statistics

Records of hunting activity and harvest were kept by officials at AAFB during the year (Table 1). According to hunter logs from AAFB, 2,061 hunter-days (3,572 sorties; gun hunting only) were expended at Northwest Field and resulted in the harvest of 81 pigs. Hunting areas on the main portion of the base (Munitions Storage Area [formerly the Conventional Weapons Storage Area], Tarague basin, and areas near the landfill and to the north and east of the flightline) recorded 505 hunter-days (1,162 sorties; primarily bow hunting), with 49 pigs killed. At Andersen South, 15 hunter-days (52 sorties; bow hunting only) were registered, with 3 pigs taken. These records indicate a total harvest of 133 pigs on AAFB. The Naval Computer and Telecommunications Area Master Station (NCTAMS) was closed to hunting this year

Table 1. Hunter effort and wild pigs taken on Andersen Air Force Base during FY98, based on official hunter logs.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Andersen Air Force Base													
<u>Northwest Field</u> (gun hunting only)													
No. hunter sorties	741	657	547	189	104	118	15	138	231	0	0	832	3,572
No. hunter days (8 hr)	456	395	313	98	55	60	7	70	124	—	—	483	2,061
Pigs taken	18	13	10	4	0	6	1	1	7	—	—	21	81
Days effort/take	25.3	30.4	31.3	24.5	—	10.0	7	70	17.7	—	—	23.0	25.4
<u>Main Base</u> (primarily bow hunting)													
No. hunter sorties	247	292	113	28	33	36	13	7	31	2	16	344	1,162
No. hunter days (8 hr)	99	129	49	10	14	15	5	3	16	7	6	152	505
Pigs taken	10	11	0	1	0	0	2	1	3	0	1	20	49
Days effort/take	9.9	11.7	—	10.0	—	—	2.5	3.0	5.3	—	6	7.6	10.3
<u>Andersen South</u> (bow hunting only)													
No. hunter sorties	25	27	0	0	0	0	0	0	0	0	0	0	52
No. hunter days (8 hr)	7	8	—	—	—	—	—	—	—	—	—	—	15
Pigs taken	2	1	—	—	—	—	—	—	—	—	—	—	3
Days effort/take	3.5	8.0	—	—	—	—	—	—	—	—	—	—	5.0

Hunter questionnaires were discontinued in FY96 because of a lack of manpower and low return rates, which may have resulted in biased sampling of the hunter community. Proposed revisions to hunting regulations may remedy this problem by requiring hunters to complete a questionnaire for the previous season prior to purchase of a new license.

Depredation Permits

Twenty-two animal depredation permits were issued in FY98. Of these, 11 permits were issued to farmers registered with the Guam Department of Agriculture. Nineteen permits authorized pig take in agricultural areas, while three permitted take in suburban areas. One permit authorized pig take on a military installation, i.e., AAFB. The requirement of a monthly report of pig take by permittees was initiated this year. Eighty-eight pigs were taken on AAFB, while 19 pigs were taken by other permittees.

Hunting Regulations

The DAWR proposed new game hunting regulations in FY98, including the unlimited year-round take of pigs in an effort to reduce the extensive habitat damage caused by this species. Oral and written testimony given during and after a public hearing held in June was generally supportive of attempts to increase the harvesting of pigs. The proposed hunting regulations will be submitted to the Twenty-fourth Guam Legislature for approval, and will hopefully be enacted for the FY00 hunting season.

Supertyphoon Paka / El Nino-Southern Oscillation

Supertyphoon Paka struck Guam on December 16-17 with estimated winds of 150-185 mph. The forests of central and northern Guam sustained extensive damage. The island subsequently experienced a severe dry season associated with an El Nino Southern Oscillation event. Continued pig rooting and wallowing magnified the habitat damage caused by these two weather events. By July, many areas (e.g., Munitions Storage Area, Tarague basin, Pati Point, and Haputo) exhibited a lack of forest undergrowth. Biologists did not observe any noticeable change in pig mortality because of the drought.

RECOMMENDATIONS

Continue to monitor the annual pig harvest and hunter participation. Hunting at NCTAMS should be reopened. Coordinate accurate record keeping and reporting of hunter effort and harvest at military bases is recommended. An increase in the hunter harvest of pigs is needed island-wide.

PROGRAM COST

The estimated cost of the wild pig project under W-1R-6 is \$30,000.

LITERATURE CITED

- Conry, P. J. 1988. Ecology of the wild (feral) pig (*Sus scrofa*) on Guam. Tech. Rept. No. 7. Div. Aquatic and Wildl. Res., Dept. Agric., Mangilao. 60 pp.
- Division of Aquatic and Wildlife Resources. 1967-1997. Job Progress Report - Federal Aid to Fish and Wildlife Restoration. Guam Dept. Agric., Mangilao.

Report prepared by: Dana T. Lujan

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-6
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Population Numbers and Distribution of Philippine Turtle-Doves
(1460, 1430)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

The Spring Bird Surveys conducted this year showed an increase in Philippine turtle-dove (*Streptopelia bitorquata*) numbers over last year's counts. Reserve Craft Beach Road and Orote Point were the only routes that recorded increases of one or more birds per station compared to last year's count. Twelve routes (52%) recorded increases in abundance, 7 (30%) decreases, and 4 (17%) had no change in bird numbers per station count.

BACKGROUND

The Philippine turtle-dove was introduced to Guam by the Spanish during their early colonization of the region, circa 1771 (Baker 1951), and has been regulated as a game bird since at least 1903 (Conry 1987). Up through the early 1960s, the turtle-dove was very common and found in large numbers in both northern and southern Guam. By the late 1960s, dove populations in southern and central Guam began to decline and have since stabilized at low levels. Populations in northern Guam declined in the late 1970s and early 1980s. Turtle-doves are now found in appreciable numbers on Northwest Field, Munitions Storage Area (MSA), and elsewhere on Andersen Air Force Base, and at moderate numbers in selected areas of central and southern Guam. A large population still remains on snake-free Cocos Island. Predation by the brown tree snake (*Boiga irregularis*) is the major cause of nest loss (Conry 1988) and this introduced pest is thought to be responsible for the population decline. Because of the decline in numbers and the extremely poor nesting success, the Department of Agriculture officially closed the turtle-dove hunting season in March 1987. The season will be reopened if nesting success improves and numbers recover to a level that can support recreational hunting.

OBJECTIVES

1. To determine present population levels and distribution, and monitor population trends.
2. To investigate nesting success and causes of nest failures.

PROCEDURES

Philippine turtle-doves were surveyed during spring bird counts conducted on 23 routes throughout the island in May. These surveys consisted of 5-minute station counts of up to

10 stations per route, with the number of birds seen or heard recorded at each station. Results are summarized as the average number of birds detected per station.

RESULTS

Spring Bird Surveys

Turtle-doves were recorded on 17 of 23 (74%) spring bird surveys conducted this year (Table 1). Snake-free Cocos Island continues to have the highest count, with an average of 2.6 birds detected per station. Eight routes, the MSA, Northwest Field, Cross Island Road, Andersen South, Reserve Craft Beach Road, Orote Point, Umatac, Dandan, and Cocos Island recorded ≥ 1.0 birds/station. Of the 23 routes surveyed, 7 (30%) recorded decreases, 12 (52%) recorded increases, and 4 (17%) recorded no change in the number birds recorded. Reserve Craft Beach Road and Orote Point were the only routes that recorded increases of one or more birds per station count compared to last year's survey.

RECOMMENDATIONS

1. Continue spring bird surveys across Guam to monitor distribution, relative abundance and population trends of the Philippine turtle-dove.
2. Keep Philippine turtle-dove hunting season closed until nesting success improves and the population recovers.

PROGRAM COST

The estimated cost of the Philippine turtle-dove project under W-1R-6 is \$7,000.

LITERATURE CITED

- Baker, R.H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. University of Kansas Pub. 3(1):1-359.
- Conry, P.J. 1987. Ecology of the Philippine turtle-dove on Guam. Tech. Report No. 6. Div. Aquatic and Wildl. Res., Dep. Ag., Mangilao.
- Conry, P.J. 1988. High nest predation by brown tree snakes on Guam. Condor 90:478-482.

Report prepared by: Celestino F. Aguon

Table 1. Numbers of Philippine turtle-doves observed per count and average number of birds per station as detected in spring bird surveys at various locations on Guam during May 1996. Values in the trend column are the difference between the average station count between years.

Survey Location	No. Stations	No. Doves Observed	1998 Ave./ Station	1997 Ave./ Station	Trend in Ave. 98-97
<u>NORTH SURVEYS</u>					
Tarague	10	1	0.10	0.00	0.10
MSA (formerly CWSA)	10	18	1.80	0.90	0.90
NWF	10	11	1.10	1.20	-0.10
NCTAMS	10	1	0.10	0.30	-0.20
Capitol Improvement Road	10	0	0.00	0.30	-0.30
Mt. Santa Rosa	10	7	0.70	0.30	0.40
Y-Sengsong Road	10	0	0.00	0.30	-0.30
Two Lover's Point	10	0	0.00	0.20	-0.20
Andersen South	10	10	1.00	0.20	0.80
Navy Golf Course Barrigada	10	2	0.20	0.10	0.10
Barrigada Hill	10	0	0.00	0.0	0.00
Toto Pipeline	8	4	0.50	0.0	0.50
<u>SOUTH SURVEYS</u>					
Nimitz Hill	10	1	0.10	0.10	0.00
Reserve Craft Beach Road	4	10	2.50	0.50	2.00
Orote Point	6	13	2.20	0.33	1.87
Pulantat	10	6	0.60	0.40	0.20
Cross Island Road	10	0	0.00	0.0	0.00
Naval Magazine	10	5	0.50	0.10	0.40
Umatac	10	0	0.00	0.00	0.00
Dandan	10	10	1.00	0.10	0.90
Ija	8	8	1.00	0.25	0.75
Merizo	8	3	0.38	0.50	-0.12
Cocos Island	10	26	2.60	2.70	-0.10

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-6
SUBPROJECT NO.: W-2
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Population Size and Distribution of Black Francolin on Guam (1460, 1430)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Black francolin (*Francolinus francolinus*) were detected on 18 of 23 (78%) survey routes conducted throughout Guam. Six routes had decreases, eleven routes had increases including four routes with increases of 1 or more birds, and six routes had no change in the number of francolin recorded.

BACKGROUND

In 1961, 171 black francolin were introduced to southern Guam as part of the Foreign Game Bird Introduction Program of the U.S. Fish and Wildlife Service. Surveys conducted in 1980 indicated the population was adequately established in most parts of southern Guam to open a hunting season. Regulations were promulgated to open a 1-month season in December 1981 with a 4-bird daily limit and a 20-bird season limit. Francolin populations continued to increase from 1980-1982, but hunting pressure remained low, probably because of the unfamiliarity of the hunting public with the sporting qualities of the bird. With the bird population increasing and little hunting pressure, the francolin season and bag limits were further liberalized in FY83 to a 2-month split season, one month in January and one month in July, and the bag limit was increased to 5 birds per day with no season limit. Revisions to the francolin season were again made in FY90, extending the season from January 1 to February 28 and from July 1 to August 31. Francolin hunting has increased in popularity and Guam hunters are successfully harvesting birds during the open seasons.

OBJECTIVES

To determine current relative abundance and current distribution of black francolin on Guam and monitor population trends.

PROCEDURES

Conduct annual island-wide spring bird surveys (five-minute station counts) to monitor distribution and status of francolin throughout the island.

RESULTS

Spring Bird Surveys

Black francolin were detected on 18 of 23 (78%) spring bird surveys conducted during May 1998 (Table 1). Six survey routes had decreases, 11 routes had increases of which

four had increases of 1 or more birds per station, and 6 routes had no change in the number of francolin recorded per count. Francolins were found on 9 of 12 routes in northern Guam, an increase of 1 from last year's results. Birds were recorded on 9 of 11 surveys south of Route 4, which was no change from last year.

Table 1. Numbers of black francolin detected per count and average numbers of birds detected per station as detected in spring bird surveys at various locations on Guam during May 1998. Values in the trend column are the difference between the average station count between years. (Ave. = average)

Survey Locations	No. Stations	No. Birds Observed	1997 Ave./ Station	1998 Ave./ Station	Trend in Average 98-97
NORTH SURVEYS					
Tarague	10	0	0.00	0.00	0.00
MSA (formerly CWSA)	10	2	0.00	0.20	0.20
NWF	10	1	0.30	0.10	-0.20
NCTAMS	10	5	1.50	0.50	-1.20
Capitol Improvement Road	10	0	0.50	0.00	-0.50
Mt. Santa Rosa	10	3	0.00	0.30	0.30
Y Sengsong Road	10	0	0.00	0.00	0.00
Two Lover's Point	10	1.7	0.90	1.70	0.80
Andersen South	10	5	0.50	0.50	0.00
Navy Golf Course	10	30	2.50	3.00	0.50
Barrigada Hill	10	16	1.50	1.60	0.10
Toto Pipeline	8	2	0.25	0.25	0.00
SOUTH SURVEYS					
Nimitz Hill	10	40	3.40	4.00	0.60
Reserve Craft Beach Road	4	0	0.00	0.00	0.00
Orote Point	6	26	1.17	4.33	3.16
Pulantat	10	26	3.00	2.60	-0.40
Cross Island Road	10	40	1.50	4.00	2.50
Naval Magazine	10	35	1.90	3.50	1.60
Umatac	10	34	2.70	3.40	0.70
Dandan	10	48	5.50	4.80	-0.20
Ija	8	51	4.13	6.38	2.25
Merizo	4	17	5.50	4.25	-1.25
Cocos Island	10	0	0.00	0.00	0.00

The results from all survey routes combined showed an increase in francolin numbers observed as compared to FY97. Two southern routes, Ija (6.38 birds per station) and Dandan (4.80 birds per station), recorded the highest number of birds per station for the entire island. The Navy Golf Course route recorded the largest number of birds per station (3.00 birds per station) for northern Guam.

Black francolin populations remain well established throughout southern Guam and in shrub-grass habitats in central and northern Guam.

RECOMMENDATIONS

Continue to monitor francolin population status, distribution, and hunter harvest.

PROGRAM COST

The estimated cost of the black francolin project under W-1R-6 is \$7,000.

This report was prepared by: Celestino F. Aguon and Jeffery Quitugua

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-6
SUBPROJECT NO.: W-3
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Population Size and Distribution of Wild Asiatic Water Buffalo on Guam

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Counts of feral water buffalo at Naval Ordnance Annex (NOA) showed no significant changes ($P > 0.05$) in number of animals recorded per km during FY98. The buffalo population on the base has shown a general increasing trend since the late 1970s.

BACKGROUND

Asiatic water buffalo (*Bubalus bubalis*) were introduced to Guam in the 1600s from the Philippines for use as beasts of burden (Wiles 1990). A population of about 2,000 water buffalo inhabited Guam prior to World War II. Many of these animals, known locally as carabao, were apparently let loose during the Japanese occupation, resulting in the creation of feral herds in the interior region of south central Guam. The Division of Aquatic and Wildlife Resources (DAWR) began conducting spotlight counts of carabao on Naval Ordnance Annex (formerly Naval Magazine) in 1966 in conjunction with Philippine deer (*Cervus mariannus*) surveys (Wiles 1990). DAWR staff recorded an average of 0.6-0.8 animals/km on NOA between 1966 and 1978 (Anderson 1980). Carabao numbers fluctuated thereafter, with a peak in 1996 when an average of 2.8 animals/km traveled was recorded (DAWR 1980-1997). Biosystems Analysis Inc. (1989) estimated the buffalo population on NOA to be 75-150 animals in 1987. More recently, 200-300 animals have been estimated to be present (Walker et al. 1996, Lujan and Wiles 1997). Illegal hunting has been a major cause of mortality in the population (Conry 1988), but expanded anti-poaching efforts on NOA by DAWR conservation officers and the Navy since the 1980s may be responsible for allowing the population to show steady growth. High buffalo densities have resulted in localized habitat damage on the base (Conry 1988, Biosystems Analysis Inc. 1989).

OBJECTIVES

To monitor the status of the feral Asiatic water buffalo on Guam and to determine if control measures are necessary to maintain the population at a level compatible with the available resources.

PROCEDURES

1. Conduct monthly spotlight counts on NOA. Analyze count data and compare with past data to estimate population trends.
2. Monitor carabao movements.

RESULTS

Spotlight Count Trends and Other Survey Results

Eight spotlight counts for water buffalo were made on NOA in FY98. The number of animals seen per kilometer showed no significant change (Mann-Whitney *U*-Test, $U = 24.5$, $P > 0.10$) from last year (Lujan and Wiles 1997), with an average of 2.3 animals/km seen this year (Table 1). A mean of 50.9 animals was recorded per count this year. The largest number of buffalo recorded on a monthly count decreased from 108 animals in FY97 to 92 animals in FY98.

Table 1. Results of monthly spotlight counts of feral water buffalo at Naval Ordnance Annex, FY98.

Month	No. animals observed	Km traveled	Animals/ km	Miles traveled	Animals/ mile
Oct	92	22.5	4.1	14.0	6.6
Dec	48	21.7	2.2	13.5	3.6
Feb	58	24.2	2.4	15.0	3.9
Apr	43	17.7	2.4	11.0	3.9
Jun	53	22.5	2.4	14.0	3.8
Jul	38	22.5	1.7	14.0	2.7
Aug	43	22.4	1.9	13.9	3.1
Sep	32	25.0	1.3	15.5	2.1
Total	407	178.5	-	110.9	-
Ave	50.9	22.3	2.3	13.9	3.7
SD	18.5	2.2	0.8	1.3	1.3

Immunocontraception of Water Buffalo

Booster vaccinations were administered by Navy, U.S. Fish and Wildlife Service, and DAWR staff to 19 of the 24 females initially treated in FY97. Five females were not vaccinated because they were either not seen or an optimal shot did not present itself. Personnel experienced an abnormally high incidence of dart malfunction. Several animals were darted twice to ensure proper vaccination. A reduction in manpower in May combined with dart malfunctions led to a lengthy darting period (March-September). Monitoring of calving by treated females continued.

Other Activities

Early-morning roadside sightings of carabao were reported from May to September in the Cotal, Canuon, and Laguina areas of Route 17. Witnesses noted herds of 4-10 animals grazing on the northern and southern sides of Route 17. Two auto-carabao collisions were reported in June. A "Carabao Crossing" sign was posted along Route 17 in July to decrease the potential for future automobile and carabao collisions. Investigations into the origin of these herds were started in late September.

RECOMMENDATIONS

Continue spotlight counts on NOA. Collect data concerning the movements of these animals, especially along Route 17.

PROGRAM COST

The estimated cost of the wild Asiatic water buffalo project under W-1R-6 is \$4,000.

LITERATURE CITED

- Anderson, R.D. 1980. Population size and distribution of wild carabao on Guam. Job Progress Report. Federal Aid to Fish and Wildlife Restoration, Guam. Guam Dept. Agric., Mangilao, Guam.
- Biosystems Analysis, Inc. 1989. Natural resources survey for the U.S. Naval Magazine, Guam (NavMag). Naval Facilities Engineering Command, Pearl Harbor, Hawaii.
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- Wiles, G.J. 1990. Population size and distribution of wild Asiatic water buffalo on Guam. Job Progress Report. Federal Aid to Fish and Wildlife Restoration, Guam. Guam Dept. Agric., Mangilao, Guam.

This report was prepared by: Dana T. Lujan.

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-6
SUBPROJECT NO.: W-4
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Survey and Inventory of Non-Game Birds (1460)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Six species of resident and migrant birds were recorded on roadside counts in northern Guam, while eight species were detected on spring bird counts made throughout the island. Censuses of island swiftlets (*Collocalia bartschi*) at Mahlac Cave indicated that the population has increased to about 400-430 birds this year. A much smaller count of 34 birds was made at Fachi Cave. Eight Mariana crows (*Corvus kubaryi*) were detected in the annual crow survey on Andersen Air Force Base (AAFB). The estimated number of crows remaining in the Guam population has fallen to 12 birds, which is a 25% decrease from last year.

BACKGROUND

Predation by brown tree snakes (*Boiga irregularis*) is the major factor in the decline of most of Guam's native bird species during the last few decades (Savidge 1987, Conry 1988, Engbring and Fritts 1988). Census data from a variety of sources have documented the extirpations of eight species, while four others have undergone severe population decreases, both in terms of overall numbers and geographic range (Division of Aquatic and Wildlife Resources [DAWR] 1963-1997, Engbring and Ramsey 1984, Wiles et al. 1995).

Common moorhens (*Gallinula chloropus guami*) continue to be scattered throughout the southern and central parts of Guam, with recent population estimates placed at 100-125 birds (Stinson et al. 1991, Ritter 1997). Island swiftlets occur primarily in one large colony on Naval Ordnance Annex. Three much smaller colonies are also known and occur on the Ordnance Annex, in the Lumuna district of Yigo, and in the vicinity of the Geus River Valley in Merizo (DAWR 1987-1997, Wiles et al. 1995). Mariana crows are now restricted to AAFB (DAWR 1992-1997, Wiles et al. 1995, National Research Council 1997). Their population was estimated at 16 birds in 1997 (DAWR 1997). Two small populations of Micronesian starlings also persist on the island, with most birds remaining on AAFB and Yigo, while smaller numbers occur on Cocos Island and coastal areas of southern Guam (DAWR 1991-1997, Wiles et al. 1995). Recovery plans have been written for each of these species except the starling (Beck and Savidge 1990, U.S. Fish and Wildlife Service 1991a, 1991b). In addition, the island continues to retain small to moderate numbers of several other resident bird species, as well as migratory shorebirds, seabirds, and waterfowl (Stinson et al. 1997a, b).

Guam experienced its most destructive storm since 1976 when Supertyphoon Paka hit the island on 16-17 December. Sustained wind speeds were estimated at 150 mph, with gusts of up to 185 mph. Information on the storm's impacts on wildlife and other natural resources appears in Appendix 1.

OBJECTIVES

To continue status surveys and natural history studies as called for in the recovery plans for Guam's endangered native birds (Beck and Savidge 1990, U.S. Fish and Wildlife Service 1991a, 1991b).

PROCEDURES

1. Roadside counts were conducted at bi-weekly intervals on three routes (North, North-Central, and Northwest Field; see previous annual reports for locations of routes) in northern Guam by DAWR conservation officers. These routes were driven at approximately 15-25 kph beginning at sunrise. Numbers and species of all birds seen or heard were recorded, irrespective of the distance from the observer.
2. Spring bird counts were conducted on 23 routes throughout Guam during June. Locations of survey route are presented in DAWR (1987). These surveys consisted of 5-minute station counts at up to 10 stations per route with the numbers of birds seen or heard recorded per species at each station.
3. Monthly visits to Mahlac Cave on Ordinance Annex were made to monitor the island swiftlet colony. When counts were conducted, observers sat at both entrances of the cave for a period of 1-2 hours before dark and recorded the numbers of birds flying in and out. The total number of birds inhabiting the cave was determined by subtracting the number of departures from the number of arrivals and by adding the number of birds estimated to be in the cave at the start of the count. During all visits, observers entered the cave for about 1 hr (prior to any counts) to record numbers of nestlings. In order to avoid disturbing nesting birds, nests were viewed from a slightly elevated position off to the side of the cave rather than by using a mirror to look inside the nests. The cave floor was searched and cleaned each month of eggshell fragments and whole eggs that had fallen from nests overhead in the guano.
4. Recorded-call playback surveys for Mariana crows were conducted in northern Guam. At each station, tape-recorded calls were played for 2.5 minutes. This was followed by a 2-minute silent period when the observer listened for crows. The numbers, distance, and plumage condition were recorded for detected birds.

RESULTS

Roadside and Spring Bird Counts

Roadside counts continue to document the status of birds in northern Guam. All five of the species recorded on the North route showed decreases in abundance this year (Table 1). Five species were also detected on the Northwest Field count, with only Eurasian tree sparrows (*Passer montanus*) increasing. The North-Central route had six species, with Pacific golden plovers (*Pluvialis fulva*) more common than in FY97 and yellow bitterns (*Ixobrychus sinensis*) equal in abundance. The general downward trend in abundance of most species may indicate that sizable numbers of birds died during Supertyphoon Paka.

Spring bird counts have been conducted annually since 1985 (DAWR 1985), but this is the first year that census results for all species have been published in the DAWR's annual reports. Eight bird species were recorded on 23 count routes during FY98 (Table 2). Comparisons of count results with previous years were not made.

Table 1. Results of North, Northwest Field, and North-Central roadside counts in FY98, showing the species and mean ($\pm$ SD) number of birds recorded per 100 km of travel.

Species	North		Northwest Field		North-Central	
	No. per 100 km	SD	No. per 100 km	SD	No. per 100 km	SD
Yellow bittern	0.0	0.0	0.4	0.3	4.7	1.2
Black francolin	3.7	2.0	0.0	0.0	4.7	2.1
Pacific golden plover	18.5	9.7	54.7	10.4	86.5	26.5
Philippine turtle-dove	7.1	5.6	18.0	3.7	8.4	2.3
Black drongo	6.4	2.7	8.3	2.7	3.4	1.1
Eurasian tree sparrow	28.2	20.4	8.3	3.7	35.1	8.1
Number of counts	13		17		15	

Table 2. Mean numbers of birds recorded per station along surveys routes in northern and southern Guam. Abbreviations are YEBI - yellow bittern, BLFR - black francolin, BBQU- blue-breasted quail, FATE - fairy tern, PTDO - Philippine turtle-dove, BLDR - black drongo, MIST - Micronesian starling, and ETSP - Eurasian tree sparrow. Black francolin and Philippine turtle-doves are also discussed in their respective reports.

Survey Location	No. Stations	YEBI	BLFR	BBQU	FATE	PTDO	BLDR	MIST	ETSP
<u>Northern Surveys</u>									
Tarague	8	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
MSA (formerlyCWSA)	10	0.0	0.2	0.0	0.0	1.8	0.5	0.0	0.1
NWF	10	0.0	0.1	0.0	0.0	1.1	0.6	0.0	0.3
NCTAMS	10	0.0	0.5	0.0	0.0	0.1	0.3	0.0	0.6
Capitol Improvemt Rd	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mt. Santa Rosa	10	0.2	0.3	0.0	1.1	0.7	1.0	0.1	2.4
Y-Sengsong Road	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Two Lover's Point	10	0.1	1.7	0.0	0.0	0.0	0.0	0.0	3.2
Andersen South	10	0.0	0.5	0.0	0.0	1.0	0.0	0.0	0.0
Navy Golf Course, Barrigada	10	0.1	3.0	0.0	0.0	0.2	0.0	0.0	1.2
Barrigada Hill	10	0.2	1.6	0.0	0.0	0.0	0.0	0.0	1.7
Toto Pipeline	8	0.6	0.3	0.0	0.0	0.5	0.0	0.0	2.2
<u>Southern Surveys</u>									
Nimitz Hill	10	0.0	4.0	0.0	0.0	0.1	0.0	0.0	0.9
Reserv Craft Beach Rd	4	1.5	0.0	0.0	0.0	2.5	0.5	0.0	6.5
Orote Point	6	0.8	4.3	0.0	0.0	2.2	0.3	0.0	0.0
Pulantat	10	0.0	2.6	0.6	0.0	0.6	0.5	0.0	1.8
Cross Island Road	10	0.1	4.0	0.2	0.0	0.0	0.2	0.0	5.2
Ordnance Annex	10	0.1	3.5	0.0	0.0	0.5	0.0	0.0	0.1
Umatac	10	0.1	3.4	0.1	0.0	0.0	0.0	0.0	0.8
Dandan	10	0.8	4.8	1.9	0.0	1.0	0.0	0.0	3.6
Ija	8	0.7	6.4	1.3	0.0	1.0	0.8	0.0	1.2
Merizo	4	0.1	4.3	0.1	0.0	0.4	0.0	0.0	0.8
Cocos Island	10	0.0	0.0	0.0	8.2	2.6	0.0	1.5	1.3

Common Moorhens

Moorhen records of special interest during FY98 are listed here: 1) Two adults and three half-grown chicks were seen in the flooded lawn at Trinity Baptist Church in Maimai, Chalan Pago on 8 October. 2) Up to five moorhens were reported at a wetland surrounded by homes across from Carbullido Elementary School in Machaute, Barrigada on 22 April. Use of this site has been documented in the past. 3) An adult moorhen was found dead along Route 10 about 100-200 m south of the mayor's office and Catholic Church in Mangilao on 15 September. The bird had been hit by a car and was probably moving between the often seasonally flooded grassy fields in the area when it crossed the highway. 4) Several adults with chicks of two size classes were observed at a newly modified wetland on the north side of the Guam International Airport in late September. This site receives rain runoff from the airport's runways and taxiways.

The Department of Public Works scraped the Barrigada ponding basin clear of all vegetation and reworked its soil contours without any environmental review in March or April. The ponding basin has been used by a single pair of nesting moorhens for a number of years, with many chicks produced. Fortunately, the site has continued to accumulate and hold water since the completion of the project and a moorhen was observed there in late September. DPW installed a new chain link fence around the basin, which should help to protect birds from dogs, cats, and humans.

Native Doves

G. Wiles heard a calling white-throated ground-dove (*Gallicolumba xanthonura*) for about 10 minutes in limestone forest along the north cliffside of Pati Point on 28 August. It was heard well and was approached to within 30 m, but was never observed. Guam did not experience any storms or periods of strong winds between Supertyphoon Paka and the date of this sighting, indicating that the bird probably dispersed to Guam during normal weather.

A member of the public reported seeing a pair of ground-doves at Andersen South on 24 September. C. Aguon confirmed the report when he heard two ground-doves calling near him at the site on 28 September.

Island Swiftlets

Mahlac Cave - Swiftlet numbers in this colony showed further recovery from the decline that occurred in FY96 (DAWR 1996). Censuses made in late January and early March 1998 tallied 430 and 396 birds, respectively (Table 3), which represents an increase of about 50-80 birds over last year's estimate of 350 birds (DAWR 1997). These were the only counts made during the year. Unusually high wasp numbers along the trail to the cave restricted observer access from April to September.

Snake trapping was not conducted at the cave this year because of the wasp problem. Large numbers of snake tracks were noted in guano from June to early October 1998 and single bundles of swiftlet feathers were found on the cave floor on 3 March and 1 June, indicating predation events. Trapping needs to be a high priority at the cave next fiscal year.

Reproductive activity in the colony continued to be monitored this year. Nesting seasonality generally agreed with observations from previous years (DAWR 1987-1997). Egg and chick production was greatest from March to early December, with a peak in

activity from March to July. The extension of nesting into December is unusual, but may reflect the delayed start of the nesting season earlier in 1997 (DAWR 1997).

Table 3. Results of censuses for island swiftlets at Mahlac and Fachi Caves on Ordnance Annex during FY98. Evidence of reproductive activities of swiftlets is also presented.

Date	Net No. of Birds Entering Cave	No. of Birds Estimated in Cave at Start of Count	Total No. of Birds Counted	Reproductive Parameters					
				No. of Whole Eggs Found on Cave Floor	No. of Eggshell Fragments on Cave Floor	No. of Nestlings Heard	No. of Nestlings Seen		
							small	med	large
Mahlac Cave									
31 October 1997	-	-	-	2	11	3-4	4	5	1
2 December	-	-	-	0	4	2-3	1	2	9
31 December	-	-	-	1	1	2	0	1	2
28 January 1998	422	8	430	2	2	2-3	3	2	3
3 March	365	31	396	0	11	4-5	5	3	7
31 March	-	-	-	7	28	4-5	4	18	7
1 May	-	-	-	2	26	4-5	7	2	10
1 June	-	-	-	4	46	4-5	11	6	15
1 July	-	-	-	2	18	3-4	1	5	14
30 July	-	-	-	3	13	1-2	6	5	7
1 September	-	-	-	1	2	1-2	2	5	10
3 October	-	-	-	0	8	3-4	8	3	3
Fachi Cave									
26 January	31	3	34	0	-	0	0	0	0

Key: - = no data gathered.

Supertyphoon Paka did not cause significant damage to the colony. Five nests appeared to have fallen to the cave floor and a number of leaves and small branches were blown inside the cave, but no other interior damage was detected. Foliage in front of the north entrance was heavily stripped, making it much easier for birds to enter and exit the cave. Results of swiftlet counts in January and March did not reveal any decline in bird numbers.

Fachi Cave – Fachi Cave again experienced flood conditions for part of the year. The cave's entrance was free of water in mid-October 1997, but heavy rains associated with Typhoon Joan resulted in the opening being nearly sealed from 20-27 October. Water levels dropped quickly so that the entrance was almost fully open again by 31 October, when one swiftlet was seen entering the cave. Heavy rains during and after Supertyphoon Keith closed the cave's opening again from 4-14 November. Water levels fell so that several feet of the entrance was exposed by 19 November and it was entirely open by 2 December. Supertyphoon Paka dumped about 53 cm of rain on 15-16 December, closing the entrance yet again until 23 December. Most of this rain fell during the night and probably sealed off the cave quickly before the swiftlets had a chance to depart at dawn. A census of 34 swiftlets was made on 26 January (Table 3) and was slightly higher than last year's results (DAWR 1997), indicating that most birds were able to safely exit the cave at some point immediately after the storm. By 31 December, the water level had fallen so that most of the entrance was open. Guam entered drought conditions in early January and flooding was not a problem at the cave during the rest of the year.

Lumuna, Yigo – A search for swiftlets in this area was made on 29 January, representing the first time that observers have returned to the location since May 1993. Three birds were seen at one site, indicating the continued existence of this small colony. Efforts to find the colony's cave were again unsuccessful.

Mariana Crows

Fourteen transects totaling 211 stations were used to survey crows in eight regions of northern Guam during July (see DAWR 1991 for transect locations). Birds were present on two (14%) transects (Table 4), which is the same number as last year (DAWR 1997). Eight crows were recorded during the survey, with six birds in the Munitions Storage Area (MSA) and two single birds southeast of Northwest Field (Table 4). Four other individuals are known to survive in the wild, giving a current population estimate of 12 birds for Guam. This estimate represents a 25% decline over last year's total (DAWR 1997).

Table 4. Summary of results from counts using playback of tape-recorded Mariana crow calls in July 1998. Locations of crows are shown in Figure 1.

Transect	No. of stations	No. of crows	No. of stations with crows	Known no. of crows missed in survey
1	50	6	4	0
2	36	0	0	1
3	12	0	0	0
4	10	0	0	0
5	8	0	0	0
6	11	0	0	0
7	10	0	0	2
8	23	0	0	0
9	9	2	1	0
10	9	0	0	0
11	7	0	0	0
12	9	0	0	0
13	8	0	0	1
14	9	0	0	0
Total	211	8	5	4

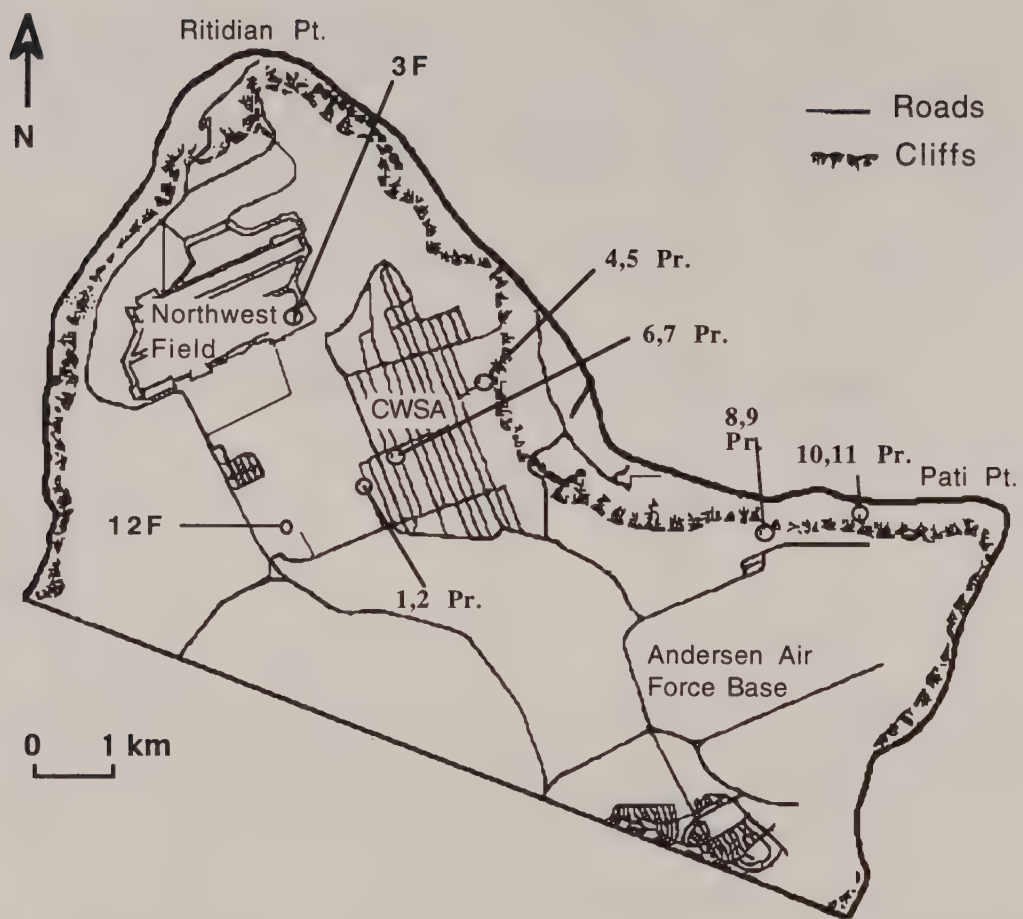
July 1998 crow population estimate = 8+4 = 12 birds

Eight detections were made on Transect 1 in the MSA, but two were repeats of the same individuals and were excluded from the count totals. The six birds in the MSA (Figure 1) include five Guam crows and a Rota female known as "Fadang", which was born in the Houston zoo and released on 14 March 1997. Fadang is paired with a male Guam crow and made her first known nesting attempt on 11 February 1998. Only a few sticks were placed on the branch of an *Elaeocarpus* tree before the structure was abandoned. This was the pair's only nesting effort during the year.

No crows were recorded on Transect 7 in the Pati Point area, however, a pair known as the "Pipeline Pair" and comprised of a Guam male and Rota female ("Pengua") continues to survive there (Figure 1). This pair made five nesting attempts during the breeding season. No other crows remain in this area.

In the Northwest Field area, no birds were observed though a hand-reared Guam female was released in the area in February 1997 (3F, Figure 1). This female was last seen in April 1997. Her current status is unknown.

The Tarague region harbors two pairs of crows (Figure 1). On the western side of the area a Guam-born pair, known as the "Mag 8 Overlook Pair", was recorded during the MSA



1&2 = 15B3 Pair, 3=Nunu, 4&5 = Mag 8 Pair, 6&7=Fadang/Male, 8&9=Faia/Ahgao, 10&11=Pengua/Pipeline Male, 12 = Reno Female

Figure 1. Location of known crows (in circles) on Andersen Air Force Base, as of July 1998. Each location is noted as a male (M), female (F), or a pair (Pr), with the number of each bird listed. Pairs 1/2 and 4/5 are old Guam crows that are not capable laying eggs. Pairs 6/7 and 10/11 are composed of a Rota female and a Guam male. Pair 8/9 is composed of Rota crows.

survey (Transect 1). This pair ranges eastward to the Tarague cliffline. A Rota pair comprised of “Faia” and “Ahgao” occupies the upper eastern Tarague plateau (Figure 1; 8, 9 Pair) and made two known nesting attempts during the year. The ranges of the two pairs overlap slightly, but no interactions were observed.

The number of crows on Guam continues to be very low because of the lack of any successful reproduction. The population will not survive much longer without the translocation of additional birds from Rota. Yearly results of Mariana crow playback surveys are listed in Figure 2.

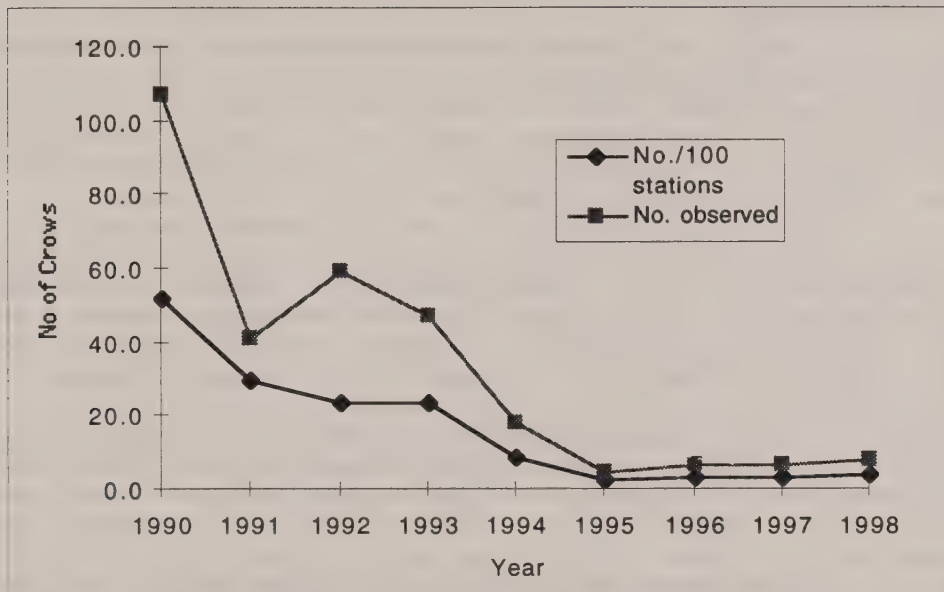


Figure 2. Yearly results of Mariana crow playback surveys conducted on Guam. The number of birds estimated in 1998 includes 4 crows released into the wild during FY97.

Micronesian Starlings

The six plywood nest boxes set out for starlings last year on AAFB were examined on 7 November. A complete nest was found in one box with an open top, while a partial nest cup was found in a box with a side opening. Neither nest could be aged. A follow-up survey made on 27 January determined that all six boxes survived Supertyphoon Paka. A pair of adults was seen using a box with an open side on this date, but an examination of contents was not made.

A juvenile starling was seen inside the front gate of NCTAMS on 29 October. This was followed by sightings of an adult near the fire station on 27 January and a pair of adults at an unidentified location in late August. These are the first reports of starlings on NCTAMS in several years.

Pacific Reef Herons

Repeated observations of reef herons on the small offshore islet several hundred meters south of Ylig Bay led to the discovery of a nest with a fully grown juvenile on 5 July. Further sightings over the next few weeks confirmed the presence of two immatures capable of flight. Both birds were still being fed entirely by their parents and neither was seen to forage on its own. At dusk, all four birds would fly off the island to roost in nearby trees along the main shoreline. All four herons were completely dark gray. Nesting has been documented at very few sites on Guam and has not been previously noted for this location.

Notable Species Recorded on Guam During FY98

Noteworthy records of birds for Guam in FY98 are presented here. An Audubon's shearwater (*Puffinus lherminieri*) was captured in Tumon on 5 December and examined by DAWR staff. A little egret (*Egretta garzetta*) was observed at the Agfayan Bay aquaculture ponds on 28 December. An unusually large mixed flock of about 75 brown (*Sula leucogaster*) and red-footed (*S. sula*) boobies was seen outside the mouth of Apra Harbor on 21 August. The flock contained approximately equal numbers of both species.

A flooded vacant construction site next to the Agana Shopping Center mall attracted several species of interest during the year, including a great egret (*Ardea alba*) on 15-20 November. An unidentified pond-heron (*Ardeola* sp.) in winter plumage appeared at the Piti mitigation wetland on 19-20 November. A moderately-sized *Buteo*-like hawk was seen along or just south of the Tarague basin cliffline on 6-7 November and 11 February.

A snowy plover (*Charadrius alexandrinus*) used Duncas Beach and the concrete pads at the Tiyan airfield from 7 October to 27 December. A black-winged stilt (*Himantopus himantopus*) occurred in the flooded lawn of the Trinity Baptist Church in Maimai, Chalan Pago on 7 October. Five stilts were seen at the Agana mall site on 13 October, with one bird still present on 12 November. Relatively large numbers of Black-winged Stilts were recorded on Guam on 13 September 1998, with five birds at the Agana mall site, two birds at the Tiyan pads, and six birds in the flooded fuel farm area of Andersen Air Force Base. An additional stilt was found injured along Route 4 at Pago Bay on 8 September, but did not show injuries consistent with being hit by an automobile when necropsied. These 14 birds represent the largest count of stilts ever for the island. Five additional stilts were seen at the Rota Golf Course ponds on 16 September, indicating that the autumn 1998 migration was unusually good for this species. The earliest date that a stilt was seen was on 3 September. One to two long-toed stilts (*Calidris subminuta*) was seen at the Tiyan pads from 7-20 September. A red knot (*Calidris canutus*), a new record for the Mariana Islands, occurred at Duncas Beach from 1-6 October. Two great knots (*Calidris tenirostris*) were present at Duncas Beach from 11-15 November and three more birds were sighted at Togcha Beach on 15 November. A pectoral sandpiper (*C. milanotos*) was observed at Ordnance Annex on 31 October. A flock of 32 wood sandpipers (*Tringa glareola*), the largest number ever documented in Micronesia, was seen at the flooded Agana mall site on 12 November. Smaller numbers of Wood Sandpipers used the site from October to December. A common redshank (*T. totanus*) was observed at the AAFB landfill on 29 September. Two to four ruffs (*Philomachus pugnax*) continued to use the Tiyan pads until 12 November after seven birds first appeared there from 27-30 August 1997. Another ruff occurred at this site on 20 September 1998. An oriental pratincole (*Glareola maldivarum*) remained at Tiyan from 9 November-8 December.

A black-headed gull (*Larus ridibundus*) in adult breeding plumage was observed at the Ordot dump for about 1-2 weeks until 12 June. A gull-billed tern (*Sterna nilotica*) was recorded daily along the beach at Ritidian Point between 4-7 November.

Three fork-tailed swifts (*Apus pacificus*) were seen foraging over the fields at the headquarters of the Guam National Wildlife Refuge at Ritidian Point on 4-5 November. A white-vented needletail (*Chaetura caudacuta*), a new record for Micronesia was seen at Tagua Point on 4 November and above the Tarague cliffline on 7 November. Single barn swallows (*Hirundo rustica*) were spotted at Naval Station on 19 August and close to Area 50 in Northwest Field on 11 September. DAWR staff shot and killed a hill myna (*Gracula religiosa*) and wounded a second individual in forest north of the AAFB runways on 18 March. The mynas had been interacting with a pair of nesting Mariana crows residing in the area, with the crows seen attempting to chase the mynas from the area. AAFB environmental personnel shot an additional hill myna near the base commissary on 6 July. No further reports of mynas have been received on the base since then (E. Henry, pers. comm.).

RECOMMENDATIONS

1. Develop and implement methods for controlling the brown tree snake.
2. Reinitiate censuses of common moorhens and develop an appropriate habitat improvement and development program.
3. Continue monthly cave censuses and efforts to assess population change and reproductive activity of island swiftlets. Consider snake-proofing Mahlac Cave to protect nesting swiftlets. Conduct further observations on the foraging behavior of swiftlets. Determine whether there is any seasonal variation in the foraging range of the colony. Interview farmers in the Talofofo River valley about the use of pesticides on their farms.
4. Continue to census Mariana crows to estimate population size and distribution.
5. Continue breeding biology studies and attempts to snake proof nest sites of crows.
6. Continue predator control efforts on Cocos Island until complete eradication of monitor lizards and feral cats is attained.
7. A review of ongoing and completed wetland mitigation projects should be made to assess the success of these projects. The evaluation should be done in cooperation with other Government of Guam agencies, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and private sector consultants.

PROGRAM COST

The estimated cost of the non-game bird project under W-1R-6 is \$33,000.

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APPENDIX 1

Assessment of Damage to Guam's Natural Resources from Supertyphoon Paka

PERIOD COVERED: December, 1997 to January, 1998

BACKGROUND

Supertyphoon Paka struck Guam on 16-17 December 1997 and is considered the most destructive storm to affect the island since Typhoon Pamela in 1976. Wind speeds were estimated at 150 mph sustained and gusting to 185 mph, which was approximately 20-30 mph faster than values recorded during Typhoon Omar in August 1992. Although weather instruments at Andersen Air Force Base (AAFB) recorded a peak gust of 236 mph during Paka, a figure widely quoted in the national news media, reevaluation of this wind speed by the Joint Typhoon Warning Center and National Weather Service after the storm indicates that actual maximum gusts were considerably lower than this. Duration of sustained winds greater than 60 mph was about 16-20 hours. Winds blew from the northwest and west during the initial half of Paka. They became more intense in the second half of the storm, coming primarily from the southwest and south. The typhoon was unusual in that it had two concentric eye walls. The center of the smaller inner eye passed through the Rota Channel, with the southern edge of the eye wall skimming Ritidian and Pati Points. The larger outer eye wall extended further south and took about six hours to cross the island in the vicinity of Chalan Pago, Ordot, and Piti. Paka dropped approximately 21 inches of rain during a 15-hr period. The storm also produced destructive surf conditions between Orote Peninsula and Tarague Beach, where sea heights were 6-30 feet above normal.

Paka caused severe damage to natural resources throughout much of Guam. An initial assessment of the destruction was made by staff of the Division of Aquatic and Wildlife Resources on 18-19 December, with follow-up field observations and surveys conducted through 16 January 1998.

Damage to Forests and other Habitats

Severe widespread damage to forests occurred north of a line extending from Malojloj to Cetti Bay, with somewhat reduced damage further south. Within northern and central Guam, pockets of greater or lesser damage to vegetation were noticeable, indicating that peak wind values differed somewhat among sites. Variation of this type was presumably caused by localized differences in 1) wind strength generated within the typhoon, or 2) topographic features, notably cliff lines, ravines, and ridgelines, that offered some protection from high winds or which channeled winds through certain sites, resulting in greater wind speeds. As noted in previous typhoons (e.g., Russ, Yuri, and Omar), forests dominated by certain tree species, such as tangantangan (*Leucaena leucocephala*), pago (*Hibiscus tiliaceus*), African tulip (*Spathodea campanulata*), and bamboo (*Bambusa vulgaris*), were particularly susceptible to high winds and displayed extreme damage. Nearly all stands of tangantangan on Guam suffered complete defoliation and some loss of branches. Specific areas of the island that were surveyed for damage are described below:

Northern Plateau - Ground and aerial surveys revealed nearly uniform forest defoliation across the top of Guam's extensive northern plateau, with minor to moderate numbers of

trees blown down. Many areas of native limestone forest showed 100% foliage loss in the mid- to upper canopy layers several days after the storm, once storm-damaged remnant foliage dried up and fell to the ground. In the worst hit locations, including sites at Pati Point, the Munitions Storage Area (formerly Conventional Weapons Storage Area), and Northwest Field on AAFB, leaf cover in the shrub and short tree layer was largely lost, giving the forest a deciduous appearance and exposing much of the forest floor to open sunlight. Limb breakage, blow downs of small trees, and destruction of epiphytes were great at these sites, but surprisingly, most canopy and emergent trees survived without being knocked down. The storm's overall effect was to give forests at these sites the appearance of being a collection of bare tree trunks standing side by side without any of the other characteristic features of a forest being present. Many stands of tangantangan in northern and central Guam also appeared this way.

Fortunately, the shrub and understory came through with only moderate damage in many forested areas on the northern plateau, as did coconuts and pandanus. Aerial observations on 2 January revealed several areas on the plateau holding considerable amounts of green vegetation, including a large site along the eastern side of the Munitions Storage Area (above the Tarague and Jinapsan basins) and smaller sites above Late, Anao, and Pagat Points.

Northern Clifflines - The aerial survey revealed a number of cliffline areas in northern Guam that retained relatively intact forest vegetation. These locations were obviously protected from the typhoon's strongest winds blowing from the southwest and south. The largest of these sites covered most of the Tarague and Jinapsan clifflines. The lower elevations of the Ritidian area were also well protected, while the cliffsides along Urunao and NCTAMS showed a mix of foliated and stripped trees. Pockets of green tree cover dotted the northeastern coastal cliffs from Fadian Point to Pati Point. However, areas immediately adjacent these sites were often heavily defoliated, showing that protection by topographic features was extremely localized. An example occurred in the Tarague basin, where coconut forest along the coast was severely impacted (many trees retained only a few hanging fronds), while inland cliffline forest experienced much less damage.

Asan and Agana Heights - A stand of 50 coconut trees next to Route 1 in the War in the Pacific National Historic Park had all of the fronds broken from their crowns. A large grove of tangantangan across the highway was also extremely damaged, indicating high winds blew through the site along a small ridge next to the trees. In contrast, coconut trees 150-200 m away (along the park's shoreline) showed much less damage.

The upper reaches of the Fonte River valley, a deep ravine east of Nimitz Hill, was fairly well protected from winds and retained much of its normal foliage after the storm. However, further downstream, where the river flows along Route 7 in Maina, the valley was severely thrashed by strong winds. Damage included many smashed bamboo clumps, palma brava palms (*Heterospathe elata*) with only remnant crowns or blown down entirely, large trees barren of leaves and branches, and large expanses of clearly visible ground.

Piti - Forests showed extreme damage along Route 1 and the west-facing inland ridgeline between the Masso and Atantano Rivers. These forests are dominated by exotics and *Hibiscus tiliaceus*, species that are particularly susceptible to high winds. Many of the large numbers of African tulip along the highway were entirely skeletonized, with only their main trunks remaining intact. The band of mangrove forest along Sasa Bay in Apra Harbor was partially stripped of foliage, but did not appear to suffer any loss of trees.

Orote Peninsula - Forests on the peninsula experienced some of the worst damage seen on the island. At locations along or adjacent to cliffsides, standing tangantangan trees were

shortened to heights of just 1.2-2.5 m, with many other individuals blown down or leaning at severe angles. Scattered native trees at these sites were commonly reduced to bare trunks and perhaps a few branches, while *Pandanus tectorius* exhibited small remnant crowns with no leaves remaining. Tangantangan forests greater than 100 m from cliffs sustained less damage and were not shortened or thinned to the same extent. On Orote Island, the tops of all trees, shrubs, and cycads growing on the west end of the island were shaved off to heights of 1.0-1.5 m. Trees on the lower eastern half of the island were damaged less severely.

Ordnance Annex (formerly Naval Magazine) - Damage to forests was quite variable, with some areas badly torn up and others much less so. Ridgetop forests along the western boundary of the installation were badly damaged, particularly on west-facing slopes. Another of the worst hit areas on the island was along the High Road between the West Tower Lookout and Mt. Alifan, where nearly all larger trees lost numerous limbs, *Pandanus* had heavily damaged crowns or were blown down, and *Casuarina* were stripped of most needles and even some bark. This area suffered similar destruction during Typhoon Omar in 1992. On the eastern side of the Annex, low lying limestone forests were defoliated and suffered broken trees on western slopes, but retained some foliage on eastern slopes.

Ipan, Talofoto - The forested cliffline bordering the southern half of Ipan was relatively protected from high winds and appeared well foliated after the storm.

Other Habitats - *Phragmites* reed beds in the Agana and Atantano marshes were severely wind blown, with the tops of most reed stalks heavily frayed. The Agana River flowing from the Agana Swamp nearly flooded its banks because of the heavy rains, and presumably the marsh was filled to near-maximum water levels. The Department of Education's mitigation marsh on Dry Dock Peninsula in Piti actually appeared to benefit from the typhoon. Heavy rains and winds inundated the wetland and created larger openings in the *Eleocharis* and invading weed beds. The *Eleocharis* reed beds showed little damage, but many of the marsh's thick accumulations of weeds were blown down.

Forest Recovery After the Typhoon

Guam's vegetation displayed initial signs of recovery fairly soon after the typhoon, with several species (tangantangan, *Hibiscus tiliaceus*, and some *Ficus* sp.) beginning to resprout new leaf shoots within six days. On AAFB, many forested areas showed ample evidence of refoitation by 13 January, with moderately dense understories present at these sites. However, canopy trees often remained sparsely foliated despite having considerable resprouting underway. Some of the tree species showing good levels of resprouting were tangantangan, *Macaranga thompsonii*, *Pandanus tectorius*, *Premna obtusifolia*, *Guamia mariannae*, *Neisosperma oppositifolia*, *Aglaiia mariannensis*, *Guettarda speciosa*, *Cestrum diurnum*, *Wikstroemia elliptica*, *Hibiscus tiliaceus*, and some individuals of *Vitex parviflora* and *Ficus* sp. In contrast, *Elaeocarpus joga*, *Artocarpus mariannensis*, and most *Cycas circinalis* continued to show little or no resprouting of leaves by this date. In some of the most heavily impacted forest sites (e.g., a *Vitex* and *Hibiscus*-dominated section of forest in the Munitions Storage Area), little new foliage had reappeared and visibility through the forest remained quite high.

Tangantangan forest displayed the fastest recovery of any forest type, with many areas having greened up considerably by mid-January. Mixed exotic and *Hibiscus* forests along Route 1 in Piti also showed rapid refoitation by this time, as did many non-forest and ornamental plant species around the island.

Effects on Wildlife

Mariana Crows - An estimated 13-17 Mariana crows existed in the wild prior to Supertyphoon Paka (C.F. Aguon, pers. comm.). Post-storm searches accounted for 9-10 surviving birds, including all four marked individuals previously translocated from zoos, but have not yet been completed for several birds. This suggests that most crows survived the storm, although several individuals were possibly lost. Three marked birds were relocated in areas close to where they had occurred before Paka, but one bird wandered about 2 km from its previous center of activity (C.F. Aguon, pers. comm.). There was no evidence that any crows sought out and inhabited pockets of less severely damaged forest (i.e., areas with greater amounts of leaf cover), with nearly all surviving birds occurring in heavily defoliated forests during the first few weeks after the storm.

During the week prior to Paka, the "Pipeline" pair of crows (consisting of a Rota female and Guam male) built a nest above the cliffline in east Tarague Basin. This nest and the entire nest tree (a large *Ficus* sp.) were lost in the high winds, however, both members of the pair had begun reneesting at a much lower elevation on Tagua Point by 5 January (C.F. Aguon, pers. comm.).

A small flock of five crows containing one translocated zoo female and four unbanded birds was observed in the Munitions Storage Area on 30 December (C.F. Aguon, pers. comm.). Flocking behavior of this type had not been recorded over the last two years and was perhaps related to the extreme defoliation of the forest, which may have facilitated birds finding one another. This aggregation was temporary and was not observed again.

No obvious evidence of food stress was observed among surviving crows since Paka (C.F. Aguon, pers. comm.). Although nearly all forest fruits were lost in the storm, the loss of foliage may have initially offset this problem by making insects easier to find and capture. As recovery of the forest understory proceeds at many sites, it is likely that adequate insect resources will continue to be available for crows.

Mariana Fruit Bats - The fruit bat colony continued to reside at its normal roosting site on Pati Point after the typhoon. Censuses revealed almost no change in numbers of animals, with counts of 168 and 158 bats made on 2 and 18 December, respectively. Several important roosting trees were snapped or blown down in the storm, causing the bats to relocate to neighboring trees. Follow-up observations revealed a sizable increase in the colony sometime between 19-21 December, which was confirmed by a count of 348 animals of 31 December. An increase of this magnitude is highly suggestive that the additional bats came from Rota rather than from elsewhere on Guam, as no other colonies are known to occur on Guam. Emigration of this type was likely caused by 1) disturbance of a bat colony by poachers, which has occurred fairly regularly on Rota during the holiday season in previous years, or 2) by a typhoon-induced shortage of foods. However, post-storm observations suggest that Rota suffered less overall forest damage than Guam (G. Hughes, pers. comm.) and did not reveal unusual numbers of daytime sightings of bats (J. Morton, pers. comm.). This indicates there was no period of foraging stress after Paka, as occurred after Typhoon Roy in 1988. On Guam, bats in the colony showed normal sleeping and social behavior on 18 and 31 December, suggesting this population also did not experience an immediate food shortage. Presumably, Guam's bats have been able to find sufficient food resources in the less damaged pockets of cliffline forest remaining after the storm, especially along the Tarague and Jinapsan clifflines.

Island Swiftlets - Visits were made to both of the island's known swiftlet caves after Supertyphoon Paka, but counts of birds were not conducted until late January to assess potential changes in population size. At the main colony site at Mahlac Cave, leaves and a

few small branches were blown into the center of the cave and five nests were found on the cave floor, but no other signs of disruption were evident. Relatively few swiftlets entered the cave during the December visit, but this is normal during this month, when nesting is greatly reduced. A census of 430 swiftlets was obtained on 28 January, which was about 80 birds more than during the last count conducted in August 1997.

As expected, heavy rains associated with Paka flooded Fachi Cave, closing off the only entrance used by swiftlets. Water levels declined fairly rapidly after the storm so that the entrance was partially open by 25 December and entirely open by 31 December. A count of 34 birds was obtained on 26 January, which is similar to the previous census made in June 1997 (31 birds).

Forests on east-facing ridgelines on eastern Ordnance Annex retained much of their leaf cover after the typhoon, meaning that some suitable foraging habitat for swiftlets probably remained.

Other Birds - The effects of Supertyphoon Paka on other bird species are more difficult to assess because pre-storm censuses were not conducted for any species. Only one report of dead birds was received by the Division of Aquatic and Wildlife Resources after the storm. Single carcasses of a brown noddy (*Anous stolidus*) and Pacific golden plover (*Pluvialis fulva*) were found blown against chain link fences at AAFB and the Guam International Airport, respectively. Three yellow bittern (*Ixobrychus sinensis*) nestlings were found dead on Naval Activities (formerly Naval Station) after Paka. The birds were on the ground and had apparently been blown from their nest(s).

General observations indicate substantial reductions in the numbers of shorebirds (plovers, tattlers, etc.) at Duncas Beach and seabirds (brown noddies and brown boobies [*Sula leucogaster*]) in Apra Harbor after the storm and suggest the possibility of significant mortality. Nesting colonies of noddies at Ana'e Island and a rock inside the entrance of Apra Harbor were devoid of birds on 28 December, as was the booby roost on Orote Island. Extensive observations on the same date detected only a single noddy elsewhere in the harbor. Boaters traveling between Cocos Island and northern Guam also reported a reduction in the abundance of noddies seen in late December and early January. However, normal numbers of noddies had returned to both nesting locations by 16 January, indicating the birds may have simply departed Guam temporarily after Paka.

Serianthes nelsonii - The island's only mature tree at Ritidian Point lost one of its main limbs, which tore a 1-m-long segment of bark from the trunk. This injury could eventually cause the tree to die. Several small seedlings beneath the tree were possibly killed from being buried under fallen leaves and branches. All seedlings (n=5) at the four outplanting sites in northern Guam survived the storm, however, all were defoliated and most suffered broken twigs or bark loss caused by rubbing against protective caging.

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Report Prepared by: Gary J. Wiles

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-6
SUBPROJECT NO.: W-4
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Survey for Mariana Crows and Their Nest Sites (1460, 1470)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Based on Mariana crow, *Corvus kubaryi*, call surveys and locations of known individuals, Guam's crow population was estimated at 12 birds. This number includes Rota crows released on Guam. Nine nests were recorded during the breeding season. Three eggs, all inviable, from two clutches were collected from the same breeding pair. Two nests, one a single-egg clutch, were lost possibly due to snake predation.

BACKGROUND

The Mariana crow is found only on Guam and Rota and is the only species of crow in Micronesia. Though once found throughout Guam, surveys in 1981 estimated 380 crows (Engbring and Ramsey 1984) were present in northern Guam. This number was much lower than the estimate of 1,300 crows on Rota in 1982 (Engbring et al. 1986). By 1986, Michael (1987) reported that only 100 crows remained on Guam. By then, most of Guam's native forest birds had disappeared as a result of brown tree snake predation (Savidge 1987, Conry 1988, Engbring and Fritts 1988). In 1990, DAWR began annual crow surveys using tape-playback of crow calls to monitor their status. The initial survey found about 100 crows still present in northern Guam. Though crow numbers had decreased since 1981, distribution remained the same (DAWR 1990).

Efforts to reverse the decline of the Mariana crow began in 1986 with attempts to protect active nest sites from snake predation. Sheet metal sleeves and Tanglefoot®, an adhesive resin, were placed around trunks of active nest trees to act as a snake barrier and snake trapping was begun. During the early 1990s, increased nest protection was achieved with the development of electrical barriers and effective snake trapping (DAWR 1991).

In 1996, a select committee appointed by the National Research Council (NRC) completed a review of the Mariana crow recovery program (NRC 1997). Their report compliments and reiterates conservation recommendations for crows found in the recovery plan (Beck and Savidge 1990). Included in their recommendations were that all birds being held in the National Zoo and Houston Zoological Garden be released on Guam. In 1997, the crow population on Guam was augmented by the release of eight captive crows (six from the zoos and two from DAWR's breeding facility) into the wild in northern Guam. Currently, four of the released birds are doing well, the status of one is unknown, and three died 13-219 days after their release.

OBJECTIVES

To inventory Mariana crows and their nest sites to implement recovery efforts, including predator control and other reproductive enhancement efforts (Beck and Savidge 1990).

PROCEDURES

1. Recorded-call playback surveys for Mariana crows were conducted in northern Guam during July (Figure 1). At each station, tape-recorded calls were played for 2.5 minutes. This was followed by a 2-minute silent period when the observer listened for crows. Numbers, distances, and plumage condition of the crows detected were recorded.
2. Areas in the northern Guam were searched during the breeding season (from October through May) for crows. Active nests were closely monitored and appropriate measures to protect them were taken. Locations of active nests were mapped.
3. Young, if found, were monitored.

RESULTS

Surveys

Mariana crows were surveyed on 14 transects totaling 211 stations in eight regions of northern Guam in July (Figure 1). Birds were present on two (14%) transects, which is the same as last year (DAWR 1997). A total of eight crows were recorded during playback surveys, including six birds in the Munitions Storage Area (MSA) and two single birds in the Northwest Field C3 area (Table 1). The number of birds recorded this year is lower than the actual number known to be surviving. Although Transect 1 in the MSA recorded ten birds, two observations were repeats of the same birds and were excluded from the total count. The six birds known from MSA included five Guam crows and a Rota female (known as "Fadang") that was born in the Houston Zoo and released in March 1997.

Table 1. Summary of results from playback of tape-recorded Mariana crow calls conducted in July 1998. The location of the transect and these crows are shown in Figures 1 and 2, respectively.

Transect	No. of stations	No. of crows	No. of stations with crows	Known no. of crows missed in survey
1	50	6	4	0
2	36	0	0	1
3	12	0	0	0
4	10	0	0	0
5	8	0	0	0
6	11	0	0	0
7	10	0	0	2
8	23	0	0	0
9	9	2	1	0
10	9	0	0	0
11	7	0	0	0
12	9	0	0	0
13	8	0	0	1
14	9	0	0	0
Total	211	8	5	4

July 98 crow population estimate = $8+4 = 12$ birds

No crows were recorded in the Pati Point area on Transect 7. However, a pair, known as the "Pipeline" pair and comprised of a Guam male and Rota female ("Pengua"), continues

to survive in the area (Figure 2). This pair made five nesting attempts during the breeding season. No other crows are known to exist in the Pati region.

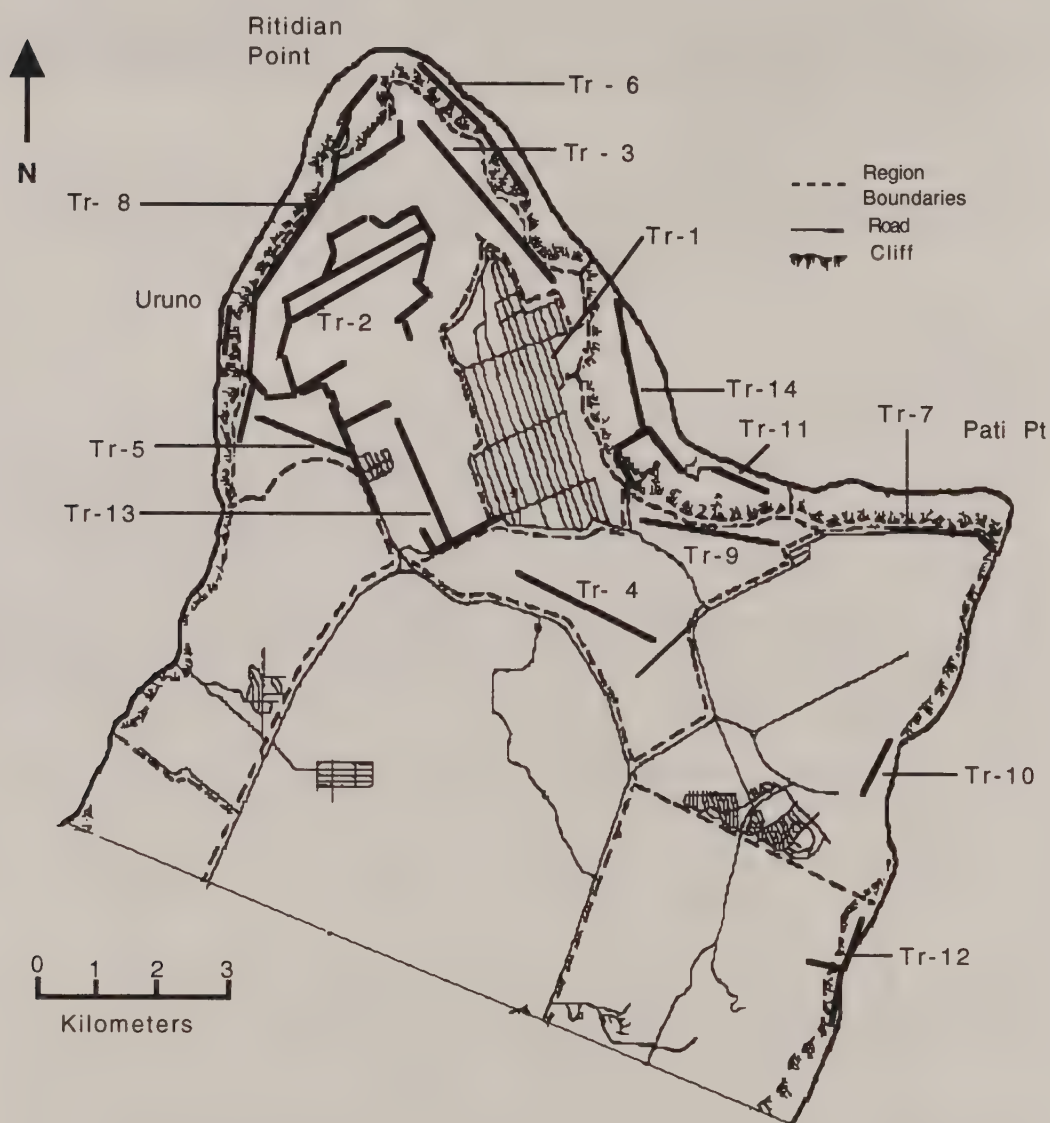


Figure 1. Locations of Mariana crow survey transects on Guam.

The Tarague region harbors two pairs of crows (Figure 2). Towards southern Tarague region, a Guam pair known as the “Mag 8 Overlook” pair was recorded on Transect 1 in the MSA. A Rota pair, known as “Faia and Ahgao”, occupies the upper Tarague Plateau (see Figure 2; 8,9 Pair) and made two known nesting attempts. Though the Mag 8 Overlook pair is known to fly between the MSA cliffline and the Tarague plateau, no interaction between this pair and the Faia/Ahgao pair was observed.

Crows were not recorded in Northwest Field. The fate of a hand-reared female Guam crow, which was released here in February 1997, remains unknown.

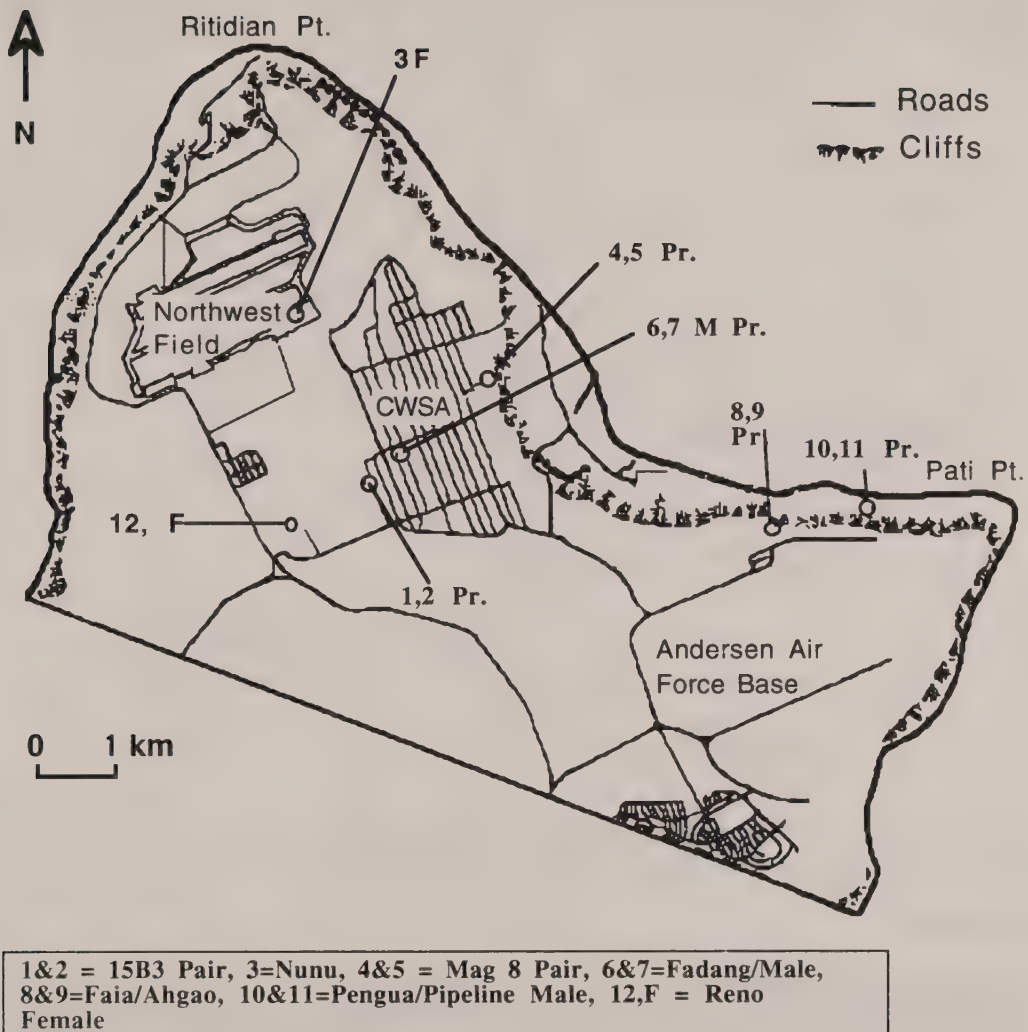


Figure 2. Location of known crows (in circles) at Northwest Field, Munitions Storage Area (CWSA), and Pati Point as of July 1998. Each location is noted as a, male (M), female (F), or a pair (Pr.). A hand-reared Guam crow's (3F) status is unknown. Pairs 1/2 and 4/5 are old Guam crows not capable of egg laying. Pairs 6/7 and 10/11 are composed of a Rota female crow and a male Guam crow. Pair 8/9 is composed of Rota crows.

When the number of birds recorded during the survey is added to the number of missed birds (excluding repeats) minus the loss of the released hand-reared bird, an estimate of about 12 crows is obtained. This represents a 25% decrease from last year's estimate. The decrease is a result of the death of several captive crows released in the wild. The number of crows on Guam continues to be very low (Figure 3) because of the lack of reproduction. This population will not persist much longer without translocating crows from Rota to Guam.

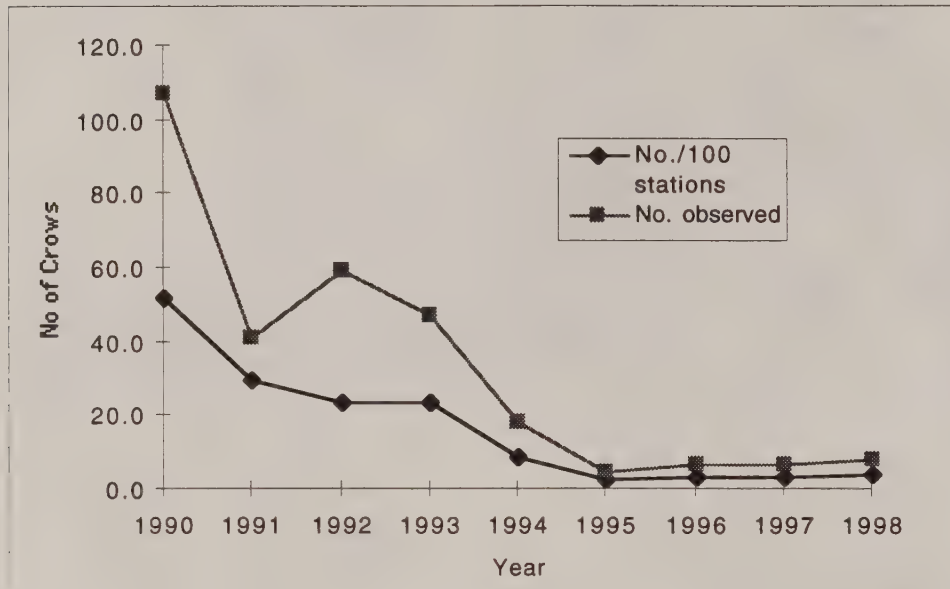


Figure 3. Yearly results of Mariana crow playback surveys conducted on Guam. The number of birds estimated in 1998 includes four Rota crows released in the wild in 1997.

Active nests

Nesting activity increased during the 1997-1998 breeding season. Nine nests were recorded this year (Table 2, Figure 4) compared to a single nest during 1996-1997. Three eggs pulled from two nests were inviable. Two other clutches were preyed on possibly by monitor lizards (*Varanus indicus*). This was the second consecutive year that no eggs hatched.

A Rota-Guam pair constructed six of the nine nests (Table 2). All were located in *Ficus* trees, except for one which was constructed in an *Aglaia mariannae* and later moved by DAWR staff to a nearby *Ficus* to allow snake-proofing. Nesting continued after the nest was relocated and the pair eventually laid two eggs. Unfortunately, neither egg was viable. Supertyphoon Paka destroyed one of this pair's nests. A Rota/Rota pair built two nests in the Tarague plateau region (Table 2). One nest was already abandoned when it was discovered on February 11. The second nest discovered on March 16 in a *Guamia* tree was abandoned probably as a result of disturbance caused by two hill mynas (*Gracula religiosa*). Both birds were shot to prevent further disturbances.

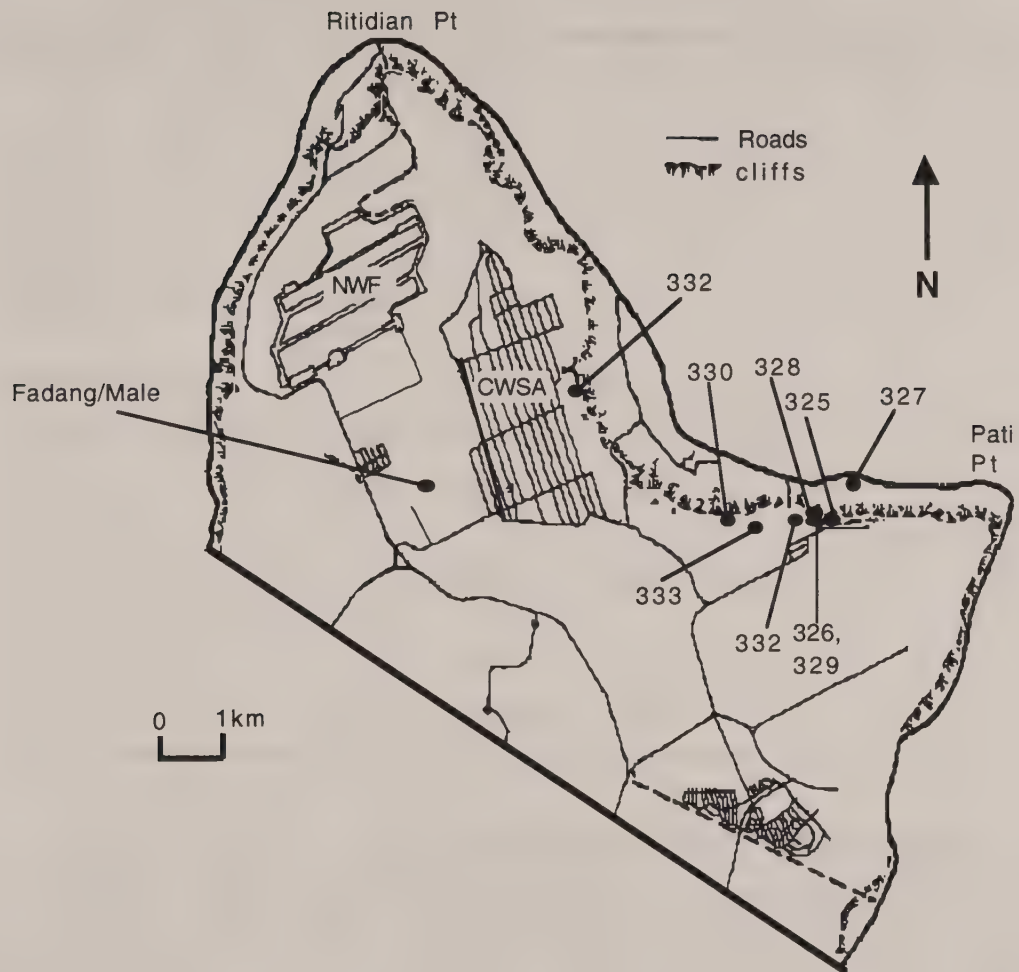


Figure 4. Locations of nests produced during the 1997-1998 crow breeding season. The Pipeline (Pengua and a male), Faia/Ahgao, and the Mag 8 Overlook pairs were the only pairs that constructed nests during the season. The Pipeline pair was the only pair that laid eggs.

Table 2. Summary of crow nests built on Guam, the stage in which they were found, and their outcome in FY98. Productivity of crows is summarized in Table 3. Pairs A, B, and C are the Pipeline/Pengua, Faia/Ahgao, Mag 8 Overlook pairs, respectively.

No.	Pair ID	Nest no.	Date discovered	Nest stage	Tree species	Date Snake-proofed	Outcome
1	A	325	11/23/97	Building	<i>Ficus</i> sp.	11/25/97	Incubation
2	A	326	12/8/97	Platform	<i>Ficus</i> sp.	N/A	Destroyed by typhoon
3	A	327	1/5/98	Early cup	<i>Aglaia mariannae</i>	1/14/98	Incubation
4	A	328	1/22/98	Platform	<i>Ficus</i> sp.	1/22/98	Abandoned
5	A	329	2/8/98	Early platform	<i>Ficus</i> sp.	2/19/98	Incubation
6	B	330	2/11/98	Complete	<i>Drypetes dolichocarpa</i>	N/A	Abandoned
7	C	331	3/5/98	Platform	<i>Tristoropsis obtusangula</i>	3/12/98	Incubation
8	A	332	3/11/98	Platform	<i>Ficus</i> sp.	3/18/98	Incubation
9	B	333	3/16/98	Base/early cup	<i>Guamia mariannae</i>	3/18/98	Abandoned

The Mag 8 Overlook pair was the only other pair known to have built a nest. Their nest was found in the MSA cliffline area on March 11 in *Tristiropsis* tree and was later snake-proofed. A dummy egg was placed in the nest on March 13, after no eggs were laid. Observations revealed that nest attendance was normal. This was the second season the pair was made to incubate a dummy egg. The female was caught, banded, and fitted with a radio transmitter, which unfortunately failed two weeks later. A pair known as the “11B6” pair probably no longer exists. The banded female was not seen during this breeding season. The male is thought to have remated with the female, “Fadang”. This pair made their first and only nesting attempt on February 11. Only a few sticks were placed in the branch of an *Elaeocarpus* tree before the structure was abandoned.

Reproductive success of Mariana crows on Guam has been documented since 1991 (Table 3). The principal cause of the low productivity is infertility probably due to senescence. With the release of Rota crows, a change from no egg-laying activity last season to egg-laying this season was observed. However, the absence of viable eggs continues to be a problem. Although techniques have been developed to control snake predation at nests through snake trapping and electrical barriers, reproductive success can only be improved by releasing young crows from Rota into the Guam’s aged crow population.

Table 3. Summary of Mariana crow nesting productivity on Guam from 1990-1998. No eggs were laid during the 1996-1997 season. The eggs laid during the 1997-1998 season were from a pair with a Rota female that was released early in 1997.

Clutch Size	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98
1	4	2	4	1	6	1	0	2
2	0	1	2	2	0	1	0	1
3	0	0	2	4	2	2	0	0
No. of Clutches	4	3	7	7	8	4	0	3
Total Eggs	4	4	12	17	12	9	0	4
Mean Clutch	1.0	1.3	1.7	2.4	1.5	2.3	0	1.3
SD	0.0	0.6	1.0	0.8	0.9	1.0	-	0.6
No. Hatched	0	3	0	3	1	3	0	0
No. Fledged	0	3	0	2	0	2	0	0

RECOMMENDATIONS

1. Continue crow surveys.
2. Continue searches for active crow nests and take appropriate measures to protect them from snake predation.
3. Collect habitat use and reproductive information when crow nests are found.
4. Augment the crow population on Guam with crows translocated from Rota.

PROGRAM COST

The estimated cost of the Mariana crow project under W-1R-6 is \$58,000.

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Report prepared by: Celestino F. Aguon and Lamont Henderson

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-6
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Current Status, Distribution, and Natural History of Mariana Fruit Bats (1460)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

During FY98, Guam's population of Mariana fruit bats (*Pteropus mariannus mariannus*) ranged in size from an estimated low of 210-245 animals in October to a high of 910-980 animals in February. Numbers were low (< 200 animals) for most of the year at the island's only bat colony. However, abundance increased sharply after Typhoon Paka, with a count of 760 bats made in February, which represents the highest single count at the colony since 1980. The colony continued to roost at a single site on Pati Point for the fourth consecutive year. In March, the U.S. Fish and Wildlife Service (USFWS) published its proposal to list fruit bats throughout the Mariana Islands as threatened, an action that includes the downlisting of Guam's bat population from endangered to threatened. Two cases of insectivorous bats being accidentally transported to Guam were reported in FY98.

BACKGROUND

The Mariana fruit bat has been studied by the Division of Aquatic and Wildlife Resources (DAWR) since 1962 (DAWR 1964-1997). Considered a delicacy by Chamorro residents, bat abundance declined during the 1960s and 1970s until only a few solitary animals remained (Perez 1972, Wheeler and Aguon 1978, Wiles 1987a). A second species, the little Mariana fruit bat (*P. tokudae*), also occurred on the island, but is now extinct (Wiles 1987a). Reasons for the declines were primarily overhunting and some loss of habitat (Wheeler 1979). Both *Pteropus* occur on the U.S. and Guam Endangered Species Lists. The island's population of Mariana fruit bats grew to an estimated 850-1,000 animals in the early 1980s, probably from immigration of bats from Rota (Wiles 1987a, Wiles and Glass 1990). However, numbers have gradually declined since 1983 because of continued illegal hunting and suspected predation by brown tree snakes (*Boiga irregularis*) (Wiles 1987a, 1987b, Wiles et al 1995). During FY97, Guam's fruit bat population ranged in size from an estimated high of 425-470 animals to a low of 210-245 animals (DAWR 1997).

Guam experienced its most destructive storm since 1976 when Typhoon Paka hit the island on 16-17 December. Sustained wind speeds were estimated at 150 mph, with gusts of up to 185 mph. Information on the typhoon's impacts on wildlife and other natural resources appears in DAWR (1998). The storm also caused significant damage on southeastern Rota. On 2-3 November, Typhoon Keith passed between Rota and Tinian, with destructive winds hitting the northern portions of Rota.

OBJECTIVES

To continue status surveys and natural history studies and to provide for continued protection of habitat as recommended in the Mariana Fruit Bat Recovery Plan (Wiles 1990).

PROCEDURES

1. Survey fruit bat distribution and numbers in Guam and the Commonwealth of the Northern Mariana Islands (CNMI).
 - a. Conduct annual surveys of fruit bats along Guam's northern cliffline with periodic surveys made elsewhere on the island. The emphasis of surveys should be to search for solitary bats and additional bat colonies.
 - b. Conduct monthly censuses at known bat colonies on Guam.
 - c. Assist the CNMI Division of Fish and Wildlife with surveys of fruit bats on other islands as needed.
2. Record information on the behavior and reproduction of fruit bats in colonies.
3. Determine habitat use of fruit bats. Visit abandoned roosts and record information about terrain and the size and abundance of vegetation present.
4. Monitor fruit bat imports to Guam from other Pacific islands.
5. Investigate illegal hunting of fruit bats on Guam. Visit abandoned roosting sites of colonies to determine illegal hunting effort. Assist conservation officers with investigations of bat poaching.

RESULTS

Locations of Bat Colonies on Guam

The island's only known fruit bat colony occupied Roost 1 on Pati Point at Andersen Air Force Base (AAFB) throughout FY98 (Tables 1 and 2). The colony did not change locations after Typhoon Paka, despite several important roosting trees being snapped or blown down, which merely caused the bats to relocate to neighboring trees. The colony has used this location since July 1994. It has been a preferred roosting site for many years (DAWR 1987-1997).

The DAWR received a second-hand report from a fairly reliable source of a small day roost of eight bats seen in a single tree along the cliffline near the municipal dump at Asiga, Malojloj, sometime between March and May.

Surveys of Fruit Bats on Guam

Count results at Roost 1 followed the same seasonal pattern noted in most previous years (DAWR 1985-1997). Fruit bat numbers were low from October to December, then began a rapid and dramatic increase from late December to February, when numbers peaked at 760 animals (Table 2). Abundance declined quickly in March and was low again from April until September. Pre- and post-Typhoon Paka counts on 3 and 18

December, respectively, showed only a small decline (Table 2), indicating little direct mortality of animals due to the storm.

The 23 February census is the largest number of bats recorded at a single roost on Guam since the colony reappeared in the northern part of the island in 1980 (DAWR 1980-1997). As previously noted (Wiles and Glass 1990, DAWR 1990-1997), the increase in abundance is attributed to the immigration of animals from Rota, as no other colonies are known to occur on Guam. Count results show that the increase did not occur as a single event. Instead, three separate increases of about 200 animals each were noted over a 10-week period (Table 2), indicating that bats may have flown to Guam in groups of up to that size or as individuals.

Table 1. Approximate dates of use of the roost used by the only known colony of Mariana fruit bats on Guam in FY98.

Roost Number	Roost location	Approximate period of use by bats
1	North Pati Point	2 July 1994 - present

Table 2. Counts of Mariana fruit bats at roosts on Andersen AFB, Guam in FY98.

Date	Roost Number									Total
	1	14	15	16	17	18	19	20	21	
8 Sept 1997	125	-	-	-	-	-	-	-	-	125
29 Oct	125	0	0	0	0	0	0	0	0	125
3 Dec	168	-	-	-	-	-	-	-	-	168
18 Dec	158	-	-	-	-	-	-	-	-	158
22 Dec	*	0	0	0	-	0	0	0	0	*
30 Dec	358	-	-	-	-	-	-	-	-	358
27 Jan 1998	556	0	0	0	-	0	0	0	0	556
23 Feb	760	-	-	-	-	-	-	-	-	760
4 Mar	374	0	0	0	0	0	0	0	0	374
30 Mar	297	-	-	-	-	-	-	-	-	297
28 Apr	173	0	0	0	-	0	0	0	0	173
29 May	163	-	-	-	-	-	-	-	-	163
30 June	145	-	-	-	-	-	-	-	-	145
11 Aug	160	-	-	-	-	-	-	-	-	160
28 Aug	145	-	-	-	-	-	-	-	-	145
6 Oct	204	-	-	-	-	-	-	-	-	204

- = site was not checked for bats; * = colony was present, but complete count was not made.

The colony's decline seemingly occurred more rapidly than its buildup. Numbers fell by more than half, or 384 animals, during the 10-day period from 23 February-4 March (Table 2), suggesting the possibility of a mass exodus back to Rota. The colony's size decreased more gradually after that, with losses of 77 bats from 4-30 March and 124 bats from 30 March-28 April.

The movement of fruit bats to Guam began soon after Typhoon Paka and may have been related to cumulative forest damage on Rota, although the evidence for this is not strong. (An especially likely alternative hypothesis is that post-typhoon or holiday season poaching caused significant disturbance to the Rota population.) Forests in some parts of Rota displayed heavy storm damage, however, the destruction was less severe overall than on Guam (G. Hughes, pers. comm.; see DAWR 1998) or on Rota after Typhoon Roy

in 1988. Despite this, increased daytime observations of bats around the island and several animals seen feeding on unripe *Pandanus* fruit suggest that the Rota bat population may have experienced some food stress after the typhoon (E. Taisacan, pers. comm.). Interestingly, the growing numbers of bats at Pati Point never appeared stressed by lack of food at any time after Paka, despite the loss of foliage and fruit over large portions of the colony's foraging range for several months after the storm (DAWR 1998). During this time, bats in the colony showed normal sleeping and social behavior and did not depart earlier than normal in the afternoon to search for food, as would be expected in hungry animals. Similarly, unusual numbers of individual bats were never observed flying about northern Guam during the daytime after the storm. Presumably, Guam's bats were able to find sufficient food resources in the less damaged pockets of cliffline forest remaining after the storm, especially along the Tarague and Jinapsan clifflines.

Estimates of fruit bat numbers at the main colony on Pati Point can be made using the high and low roost counts for the year. Because some individuals were probably hidden by thick foliage during counts, the total number of adults in the roost was likely to be 5-10% higher than the actual number recorded. Assuming that about half the colony were harem females and that 10% of these had unweaned young (DAWR 1994), then the roost held an estimated high of 798-836 adults and 40-42 juveniles, or a total of 838-878 bats in late February, and a low of 131-138 adults and 7 juveniles, or a total of 138-145 bats in October.

Incidental sightings of single fruit bats or pairs of bats were made elsewhere on the island during the year, as follows: daytime sightings – Ritidian Point (9 sightings), Munitions Storage Area (formerly the Conventional Weapons Storage Area) on AAFB (8), Tarague basin cliffline (3), Northwest Field (1), 200-400 m west of Wettengel Elementary School in Dededo (1), Fadian Point (1), Harmon cliffline (1), the Ngachang area of Ordot (3), Ordnance Annex (1), Bubulao in Talofofo (2), and Nomna Beach in Malojloj (1); nighttime sightings – Tagua Point on AAFB (1), Northwest Field (1), single bats flying between AAFB and NCTAMS at Potts Junction (2), a bat flying across Route 3 from Gugagon, Dededo to NCTAMS (1), Haputo Beach on NCTAMS (1), Route 1 at the west entrance of Andersen South (2), and the DAWR office in Mangilao (1, this bat flew over the office at dawn).

Excluding bats residing in the colony at Pati Point, an estimated 50-75 fruit bats are still believed to live solitarily or in small groups in northern Guam, primarily along the cliffline extending from Bijia Point to Iates Point. An additional 20-25 animals probably inhabit the Ordnance Annex and other forested areas in southern and central Guam. Based on these figures, Guam's islandwide population of fruit bats was small for much of the year, with an estimated low of 210-245 animals in October and a high of 910-980 animals in February.

During the review of the USFWS proposal to list Mariana fruit bats as threatened in the CNMI (see below), doubt was expressed by some CNMI citizens over the claim that bats fly between islands of the archipelago, as noted in U.S. Fish and Wildlife Service (1998). DAWR researchers believe that only a single colony of bats remains on Guam and therefore any increases in the numbers of animals at that colony must be due to immigration from Rota rather than from intra-island movement. However, DAWR personnel have been unable to conduct exhaustive searches of bat habitat in other parts of Guam to verify the lack of additional colonies. To this end, archaeologists with International Archaeological Research Institute, Inc. reported the completion of three extensive field studies in several poorly surveyed cliffline areas of northern Guam (R. Olmo, pers. comm.). These included 1) the area from Haputo Cove to Double Reef on NCTAMS (a one-month survey from May to July 1998), 2) the area from FAA cove

southward through all of Hilaan (three weeks in 1998), and 3) the entire Tarague Basin and cliffline from Mergagan Point southeast to Tagua Point (two months in 1996). They encountered no colonies and saw almost no bats during this fieldwork. These observations, plus the likely absence of colonies near the private lands at Urunao and Jinapsan, support the contention that no bat roosts occur between Two Lovers Point and Pati Point.

Surveys of Fruit Bats on Other Islands

The DAWR did not assist in any bat surveys in the CNMI during FY98.

Illegal Hunting and Importations

Poaching has long been a major cause of mortality of *P. mariannus* in the southern Mariana Islands (Wiles 1987a, Wiles et al. 1989, Stinson et al. 1992). Poaching still occurs commonly on Rota and other islands in the Marianas (E. Taisacan, pers. comm., 1998). No reports of illegal hunting were again recorded on Guam this year.

Several illegal shipments of bats were confiscated by customs authorities on Guam and in the CNMI during the year (R. Born, USFWS, pers. comm.). Confiscations made on Guam totaled: two shipments from Rota of three and two bats, and six bats from Yap in one shipment. Confiscations on Saipan were as follows: one bat from Sarigan and one bat from Rota in two separate shipments.

Proposed Downlisting of the Mariana Fruit Bat Population on Guam

In March, the USFWS published its proposal to list Mariana fruit bats throughout the Mariana Islands as threatened (U.S. Fish and Wildlife Service 1998). This action would include the downlisting of Guam's bat population from endangered to threatened. A public comment period was opened from March to June and public hearings were held on Saipan and Rota in June. A final decision on the ruling is pending.

Insectivorous Bats

Two separate cases of insectivorous bats being accidentally transported to Guam were reported in FY98. The first occurred on 26-27 October, when two bats were discovered alive inside a well-sealed concrete house on Nimitz Hill. The couple living there had returned from a trip to Bali only a few hours before finding the first bat, thus it is likely that the animals were accidentally carried inside a souvenir packed in their luggage. Neither bat was recovered for identification. On 28 November, Guam customs officers answered a report of a dead bat found aboard a recently arrived ship in Apra Harbor. The bat was retrieved and turned over to the DAWR. It was sent to the National Museum of Natural History (USNM 568000) and identified as *Nyctalus noctula*. Prior to ship's arrival at Guam, it had stopped in Hong Kong from 12-15 November, where this species is an uncommon resident. A full report on the finding of the three bats is in preparation.

RECOMMENDATIONS

1. Survey bat numbers and distribution along Guam's entire northern cliffline once or twice annually. Searches for additional colonies may be productive because continued poaching at bat roosts on Rota can cause large numbers of bats to move to Guam (Wiles and Glass 1990).

2. Continue observations at Guam's bat colonies. Information on reproductive biology, behavior, and social organization will be used to supplement data already gathered.
3. Summarize data previously collected and write reports on the diet, reproduction, and amount of snake predation on fruit bats.
4. Conduct a study of the vegetation, terrain, and proximity to development of known roosting sites to determine what site characteristics are important in the selection of roosting sites by fruit bat colonies.
5. Known bat roosting and foraging areas should be patrolled regularly by DAWR conservation officers.
6. Continue to assist the CNMI as needed with island censuses and other biological studies. Studies conducted on Rota would be most valuable for understanding the aspects of Guam's fruit bat population.
7. Continue to monitor illegal fruit bat imports entering Guam.

PROGRAM COST

The estimated cost of the fruit bat project under W-1R-6 is \$22,000.

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Report prepared by: Gary J. Wiles

PROGRESS REPORT COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-6
SUB-PROJECT NO.: W-6
STUDY.: 1
JOB NO.: 1

JOB TITLE: Technical Guidance to Projects Affecting Guam's Wildlife Resources
(1210)

PERIOD COVERED: October 1, 1997 to September 30, 1998

BACKGROUND

The Wildlife Section professional staff of the Division of Aquatic and Wildlife Resources (DAWR) devoted a significant percentage of their time and effort to technical assistance. The pace of development on the island is requiring increasing amounts of time from the Section's staff to fulfill its statutory responsibility to review and comment on development plans, rezoning applications, and various permit applications most of which are local Government of Guam or private sector. In addition, the Section also provides comment and review of numerous activities and proposals from the military bases on Guam that may affect Guam's endangered species and wildlife resources and their habitat. Often this includes commenting on U.S. Fish and Wildlife Service (USFWS) Section 7 consultations concerning impacts of military projects on endangered species. Because of the size and complexity of some of these developments, the Section's review responsibility will require a continuing commitment that often extends beyond project completion.

The professional staff in the Wildlife Section provide technical support to the Division's technical assistance program staff and often take the lead in the review of projects involving their particular expertise, such as those that may have endangered species impacts or those involving wetlands. This effort is extremely important for the management and conservation of Guam's natural resources.

OBJECTIVES

1. To minimize adverse environmental impacts resulting from the construction of recreational, commercial, residential, industrial, military, or public utility facilities.
2. Provide technical assistance to farmers and other landowners, including private, territorial, and federal, for controlling wildlife damage to crops, native habitat, and other property.
3. Provide technical assistance to military and civil agencies relative to the management and protection of Guam's wildlife resources.
4. Provide data and analyses to assist the Department in promulgating hunting regulations for the Territory to provide recreational opportunities for the public, control damage to native habitat, and other needs as they arise.

FINDINGS

Wildlife Section staff have been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications,

which were submitted to the Division for review, required the Wildlife Section's assistance. Field investigations and meetings with responsible agencies have been conducted in many cases as a part of the review process.

Various Section staff members actively serve as members of the following groups:

1. Region IX Regional Response Team - Oceania
2. Fish and Wildlife Natural Resource Committee- Andersen Air Force Base
3. Pacific Islands Recovery Team USFWS
4. Mariana Crow Recovery Team
5. Captive Breeding Working Group, USFWS
6. Area Committee for Oil Spills

Members of the Wildlife Section have attended numerous meetings and hearings pertaining to the protection of Guam's natural resources and have actively consulted with various civil and military agencies on environmental matters. Section staff maintain close liaison with the Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency (GEPA), University of Guam, U.S. Army Corps of Engineers (ACOE), USFWS, U.S. National Marine Fisheries Service, U.S. Navy, Coast Guard, and Air Force regarding matters of environmental concern. In addition, staff members actively consulted with numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

Considerable public contact was maintained by Section staff during the reporting segment. In addition to occasional interviews on radio, television, and in newspapers, staff members gave talks to a number of civic groups, sportsman clubs, and school and university classes. Some more specific Technical Assistance activities of the Wildlife Section included:

1. The Division reviewed and commented on ACOE applications for wetland fill. Mitigation recommendations were often included in these comments. Comments and concerns were also provided to various local agencies. Wildlife staff provided significant input into the responses for these applications. Endangered species were of primary concern to the Section with Mariana common moorhens found in most wetlands on Guam.
2. The Section provided technical support to the Division's enforcement staff by identifying and evaluating wildlife, testifying at court hearings, and recommending disposition for confiscated wildlife.
3. Section staff provided technical assistance to the Department of Agriculture's Plant Protection Quarantine Division by identifying confiscated wildlife and wildlife products, holding wildlife in quarantine, and in general supporting their efforts at preventing illegal imports of wildlife to Guam.
4. The Division reviewed and commented on numerous Environmental Impact Statements/Assessments of proposed developments particularly when wildlife issues were present. These comments included recommendations for grading and clearing, erosion control, project design and orientation. These recommendations were made to reduce and/or eliminate impacts to the immediate and adjacent environments.

5. The Division's Wildlife Section provided comments at the request of the USFWS for numerous Section 7 Consultations under the Endangered Species Act, including the following:
 - a. Several construction projects at U.S. Naval Ordnance Annex Guam.
 - b. Numerous military training exercises at AAFB and Naval bases on Guam.
 - c. Several wetland-related development activities for civilian and military projects.
 - d. Dept. of Defense programmatic EIS for military training in the Mariana Islands.
6. The Section reviewed and commented on several legislative bills that would affect wildlife.
7. The Section responded to many requests for information on laws and regulations pertaining to fish, wildlife, endangered species, hunting and fishing, and importation of wildlife.
8. The Section responded to numerous public requests for information on native wildlife, particularly endangered species.
9. The Section answered numerous requests for information on hunting from both on and off-island individuals. Specific requests included information on hunting areas, hunter safety classes, firearms regulations, hunting seasons and limits, and laws and regulations.
10. Section staff provided technical assistance to numerous farmers and the Air Force and Navy regarding damage by wild pigs, deer, and carabao (water buffalo). Damage control permits requests were evaluated and issued when warranted.
11. Section staff reviewed wildlife-related manuscripts for professional journals. One of our staff is an editor for the University of Guam's journal *Micronesica* and in this capacity reviewed several articles for publication.
12. Section staff assisted in presented hunter safety briefings at Anderson Air Force Base, the Mangilao Community Center, and the University of Guam to provide pertinent information to hunters.
13. Section staff made numerous presentations on fish and wildlife resources at meetings of various organizations during the year.
14. Section staff prepared numerous press releases to keep the public informed of fish and wildlife issues including hunting and hunting seasons, brown tree snake issues, fish and wildlife laws and regulations, endangered species, fish and wildlife importation, etc.
15. Technical assistance and logistic support was provided to various personnel from the USFWS, USGS Biological Resources Division, U.S. Department of Agriculture's Wildlife Services working on the brown tree snake problem on Guam and in the mainland U.S.
16. The Section staff, at the request of numerous developers, met with them, their consultants and other government representatives to discuss proposed development

projects and their potential impacts on endangered species, wetlands and native habitat as well as erosion, project design, etc.

17. Section staff provided technical assistance to USFWS and National Marine Fisheries Service law enforcement personnel on various matters including the importation of endangered species items.
18. Technical advice on wetland issues have been provided to the Development Review Section at GEPA.
19. Section staff participated in the Navy Installation Restoration Program by providing information to Navy consultants, accompanying them on several site visits, and attending public meetings.
20. Section staff provided technical support to the ACOE, GEPA, and Navy in evaluating severe erosion and damages to wetland resources caused by firebreak maintenance at Naval Ordnance Annex. Recommendations were made for mitigation of the environmental damage.
21. Staff gave visiting lectures for various University of Guam biology classes on wildlife related topics.
22. Section staff assisted the military in planning field training exercises at various military bases on Guam so that endangered species and their habitat and other wildlife resources would be minimally impacted. Military units involved included:
 - a. Guam National Guard
 - b. Various Air Force units
 - c. Air National Guard
 - d. University of Guam Army ROTC
 - e. Various DOD special operations units
 - f. U.S. Army Reserves
23. Section staff on numerous occasions met with representatives of the press to discuss wildlife issues the media was interested in. Contact was made with the following organizations:
 - a. Pacific Daily News, Guam
 - b. KUAM TV News, Guam
 - c. Guam Cable TV News
 - d. KGTF public radio, Guam
 - e. K-57 radio news, Guam

PROGRAM COST

The estimated cost of the technical assistance project under W-1R-6 is \$44,000.

RECOMMENDATIONS

Continue technical assistance activities in support of the conservation of Guam's wildlife.

This report was prepared by: Robert Beck

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-2-1
SUBPROJECT NO: A
JOB NO.: 1

JOB TITLE: Reproductive Biology of the Mariana Crow and Other Endangered Species (1460, 1470)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Based on Mariana crow call surveys and locations of known individuals, the crow population on Guam was estimated at 12 birds. This number includes Rota crows released on Guam. Nine nests were recorded during this breeding season. Three eggs, all enviable from two clutches, were collected from the same breeding pair. Two nests, one a single-egg clutch, were lost probably due to snake predation.

BACKGROUND

The Mariana crow is found only on Guam and Rota and is the only species of crow in Micronesia. Though once found throughout Guam, surveys in 1981 estimated 380 crows (Engbring and Ramsey 1984) were present in northern Guam. This number was much lower than the estimate of 1,300 crows on Rota in 1982 (Engbring et al. 1986). By 1986, Michael (1987) reported that only 100 crows remained on Guam. By then, most of Guam's native forest birds had disappeared as a result of brown tree snake predation (Savidge 1987, Conry 1988, Engbring and Fritts 1988).

In 1990, DAWR began annual crow surveys using tape-playback of crow calls to monitor their status. The initial survey found about 100 crows still present in northern Guam. Though crow numbers had decreased since 1981, distribution remained the same (DAWR 1990).

Efforts to reverse the decline of the Mariana crow began in 1986 with attempts to protect active nest sites from snake predation. Sheet metal sleeves and Tanglefoot ®, an adhesive resin, were placed around trunks of active nest trees to act as a snake barrier and snake trapping was begun. During the early 1990s, increased nest protection was achieved with the development of electrical barriers and effective snake trapping (DAWR 1991).

A review of the Mariana crow recovery program was recently completed by the National Research Council (1997). This report compliments and reiterates recommendations in the recovery plan for the Mariana crow (Beck and Savidge 1990). One of their recommendations was that all Mariana crows being held in the National Zoological Park Conservation Research Center and Houston Zoo be released on Guam. In 1997, the crow population on Guam was augmented by the release of 8 captive crows (6 from the zoos and two from the DAWR's facility) into the wild in northern Guam. At the end of FY97, four of the released birds were still surviving, the status of one was unknown, and three died 13-219 days after their release.

OBJECTIVES

To inventory Mariana crows and their nest sites to implement recovery efforts, including predator control and other reproductive enhancement efforts (Beck and Savidge 1990).

PROCEDURES

1. Recorded-call playback surveys for Mariana crows were conducted in northern Guam during the month of July (Figure 1). At each station, tape-recorded calls were played for 2.5 minutes. This was followed by a 2-minute silent period during which the observer listened for crows. The numbers, distance, and plumage condition of the crows observed were recorded.
2. Areas in northern Guam were searched for Mariana crows during the breeding season (October to May). Active nests were monitored and appropriate measures to protect nests were taken. The locations of active nests were mapped (Figure 4).
3. Young, if found, were monitored.

RESULTS

Surveys

Fourteen transects totaling 211 stations were used to survey crows in eight regions of northern Guam during July (see DAWR 1991 for transect locations). Birds were present on two (14%) transects (Table 1), which is the same number as last year (DAWR 1997). Eight crows were recorded during the survey, with six birds in the Munitions Storage Area (MSA) and two single birds southeast of Northwest Field (Table 1). Four other individuals are known to survive in the wild, giving a current population estimate of 12 birds for Guam. This estimate represents a 25% decline over last year's total (DAWR 1997).

Table 1. Summary of results from playback of tape-recorded Mariana crow calls conducted in July 1998. The location of the transect and these crows are shown in Figures 1 and 2, respectively. July 98 crow population estimate = $8+4 = 12$ birds. † = known number.

Transect	No. of stations	No. of crows	No. stations with crows	Crows missed in survey†
1	50	6	4	0
2	36	0	0	1
3	12	0	0	0
4	10	0	0	0
5	8	0	0	0
6	11	0	0	0
7	10	0	0	2
8	23	0	0	0
9	9	2	1	0
10	9	0	0	0
11	7	0	0	0
12	9	0	0	0
13	8	0	0	1
14	9	0	0	0
Total	211	8	5	4

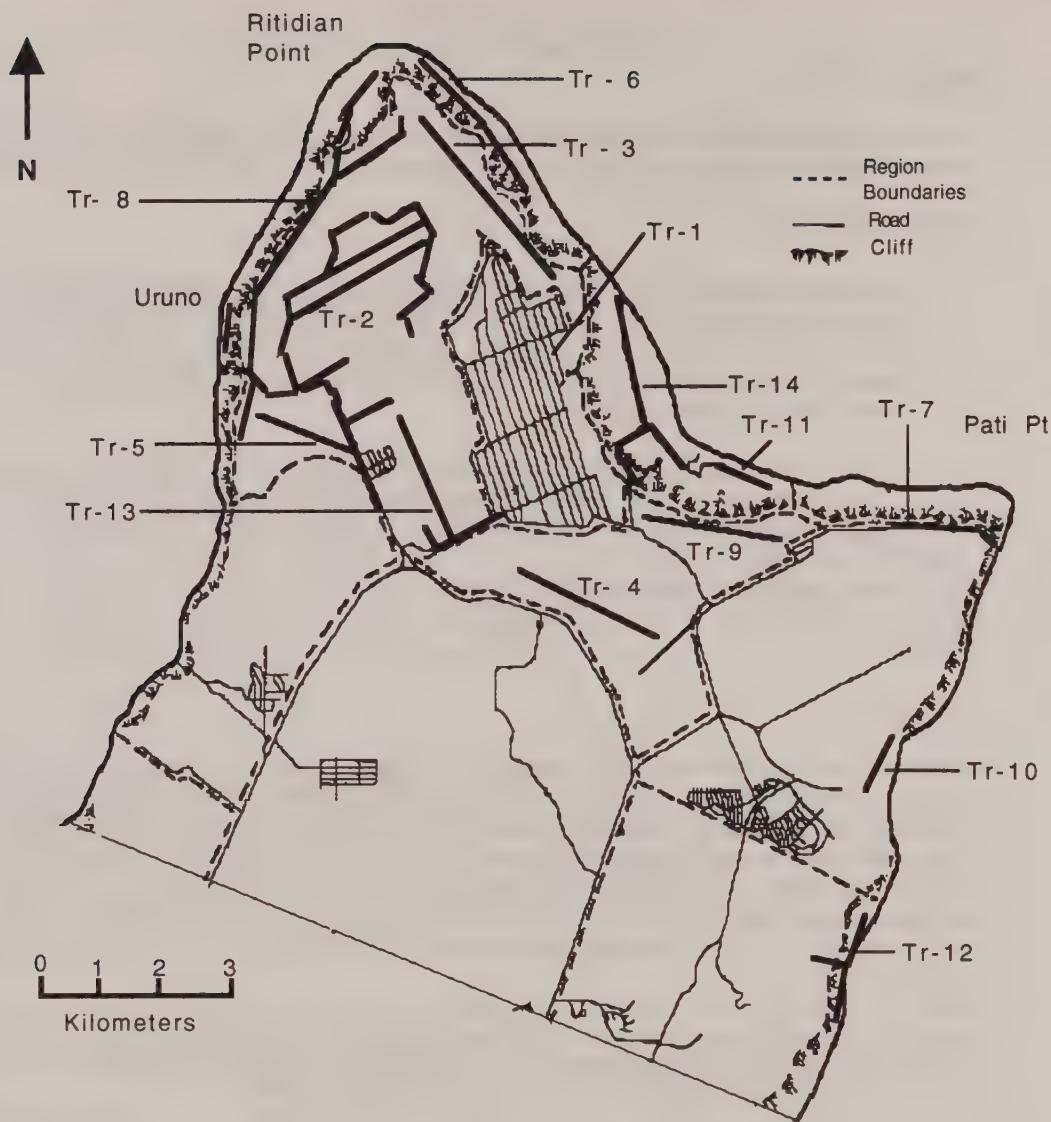


Figure 1. The location of Mariana crow survey transects on Guam.

Eight detections were made on Transect 1 in the MSA, but two were repeats of the same individuals and were excluded from the count totals. The six birds in the MSA (Figure 1) include five Guam crows and a Rota female known as “Fadang”, which was born in the Houston zoo and released on 14 March 1997.

No crows were recorded on Transect 7 in the Pati Point area, however, a pair known as the “Pipeline Pair” and comprised of a Guam male and Rota female (“Pengua”) continues to survive there (Figure 1). This pair made five nesting attempts during the breeding season. No other crows remain in this area.

The Tarague region harbors two pairs of crows (Figure 2). On the western side of the area a Guam-born pair, known as the “Mag 8 Overlook Pair”, was recorded during the MSA survey (Transect 1). This pair ranges eastward to the Tarague cliffline. A Rota pair comprised of “Faia” and “Ahgao” occupies the upper eastern Tarague plateau (Figure 1; 8,

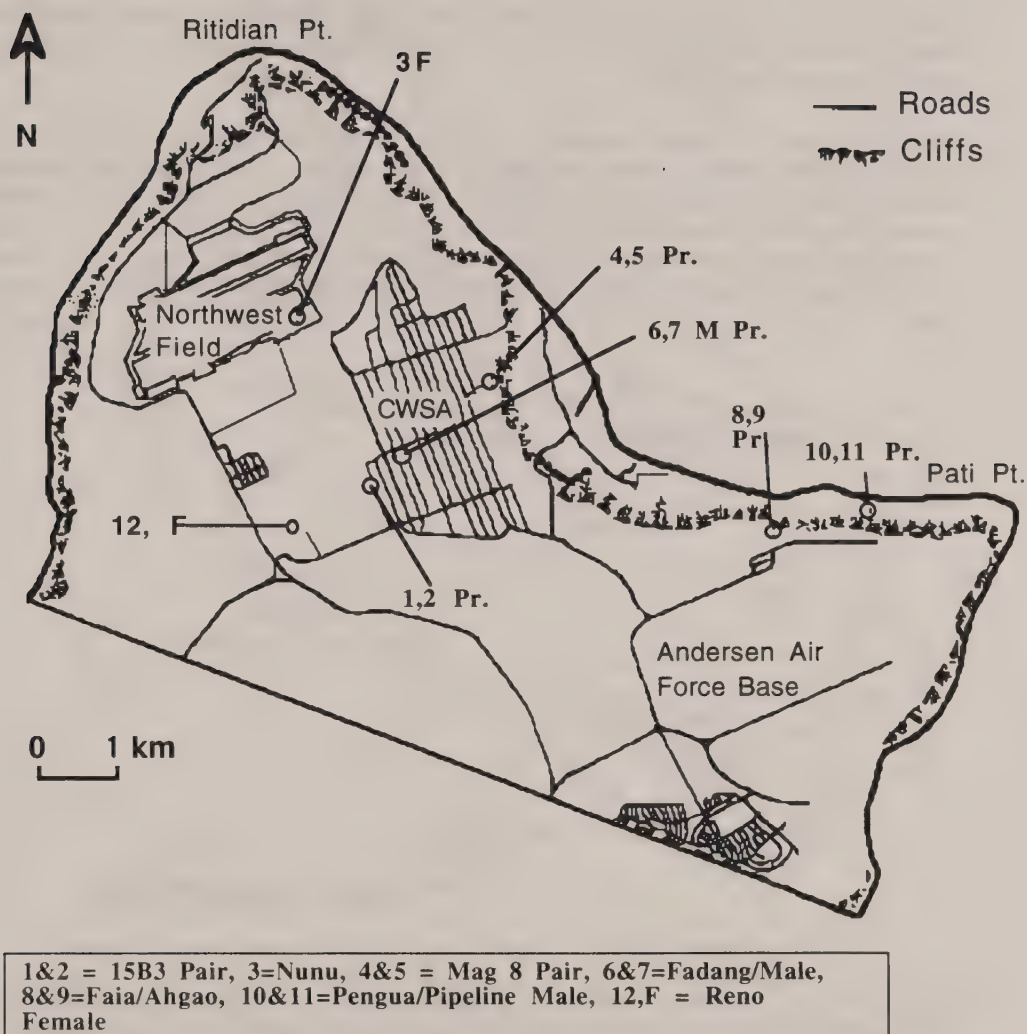


Figure 2. Location of known crows (in circles) at Northwest Field, Munitions Storage Area (CWSA), and Pati Point as of July 1998. Each location is noted as a, male (M), female (F), or a pair (Pr.). A hand-reared Guam crow's (3F) status is unknown. Pairs 1/2 and 4/5 are old Guam crows not capable of egg laying. Pairs 6/7 and 10/11 are composed of a Rota female crow and a male Guam crow. Pair 8/9 is composed of Rota crows.

9 Pair) and made two known nesting attempts during the year. The ranges of the two pairs overlap slightly, but no interactions were observed.

Crows were not recorded in Northwest Field. A hand-reared female Guam crow was released there in February 1997, but her radio failed, making observations difficult. Her status is presently unknown.

When the number of birds recorded during the survey is added to the number of missed birds (excluding repeats) minus the loss of the released hand-reared bird, an estimate of about 12 crows is obtained. This represents a 25% decrease from last year's estimate. The decrease is a result of the death of several captive crows released in the wild. The number of crows on Guam continues to be very low (Figure 3) because of the lack of reproduction. This population will not persist much longer without translocating crows from Rota to Guam.

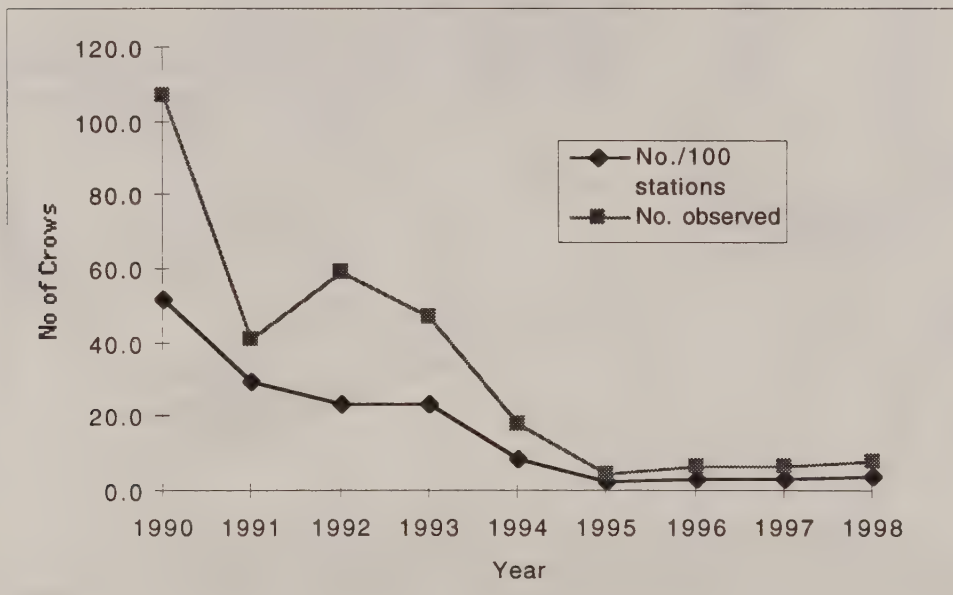


Figure 3. Yearly results of Mariana crow playback surveys conducted on Guam. The number of birds estimated in 1998 includes four Rota crows released in the wild in 1997.

Active nests

Nesting activity increased during the 1997-1998 breeding season. Nine nests were recorded this year (Table 2, Figure 4) compared to a single nest during 1996-1997. Three eggs pulled from two nests were inviable. Two other clutches were preyed on possibly by monitor lizards (*Varanus indicus*). This was the second consecutive year that no eggs hatched.

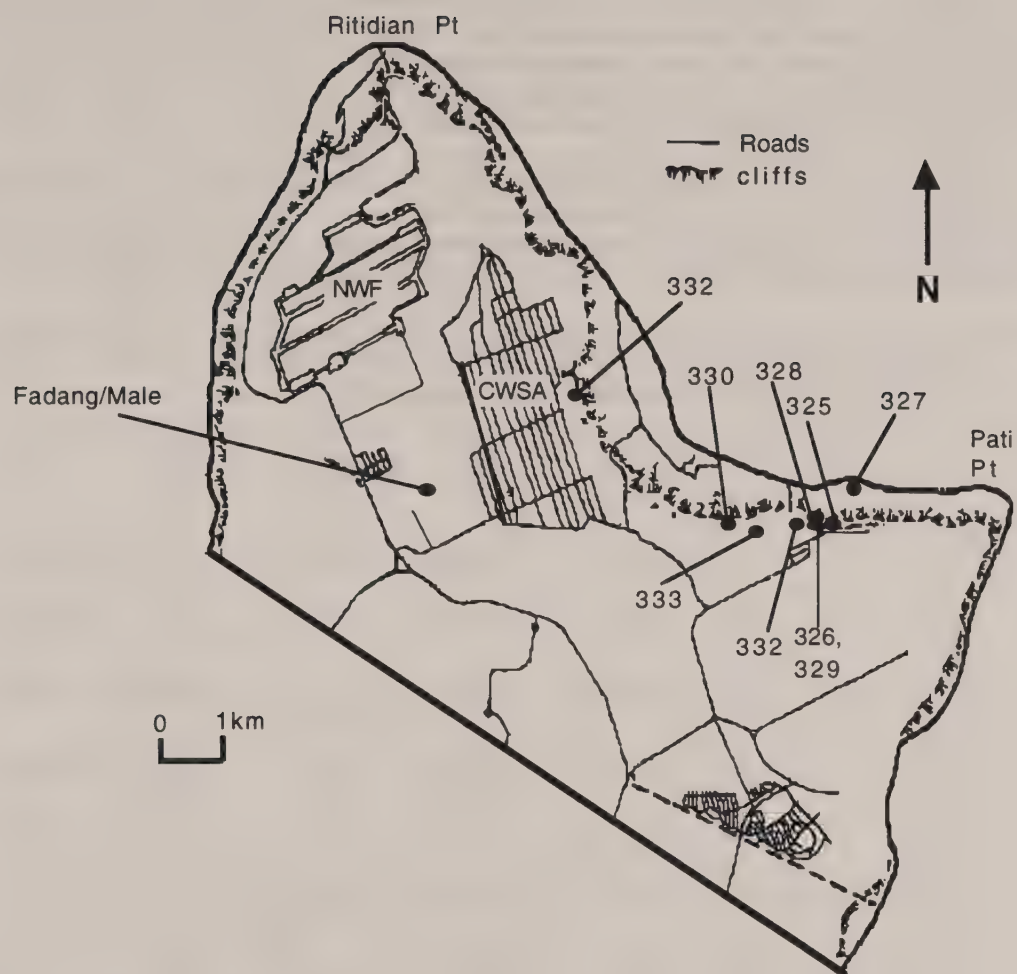


Figure 4. Locations of nests produced during the 1997-1998 crow breeding season. The Pipeline (Pengua and a male), Faia/Ahgao, and the Mag 8 Overlook pairs were the only pairs that constructed nests during the season. The Pipeline pair was the only pair that laid eggs.

A Rota-Guam pair constructed six of the nine nests (Table 2). All were located in *Ficus* trees, except for one which was constructed in an *Aglaia mariannae* and later moved by DAWR staff to a nearby *Ficus* to allow snake-proofing. Nesting continued after the nest was relocated and the pair eventually laid two eggs. Unfortunately, neither egg was viable. Supertyphoon Paka destroyed one of this pair's nests.

A Rota/Rota pair built two nests in the Tarague plateau region (Table 2). One nest was already abandoned when it was discovered on February 11. The second nest discovered on March 16 in a *Guamia* tree was abandoned probably as a result of disturbance caused by two hill mynas (*Gracula religiosa*). Both birds were shot to prevent further disturbances

Table 2. Summary of crow nests built on Guam, the stage in which they were found, and their outcome in FY98. Productivity of crows is summarized in Table 3. Pairs A, B, and C are the Pipeline/Pengua, Faia/Ahgao, Mag 8 Overlook pairs, respectively.

No.	Pair ID	Nest No.	Date Discovered	Nest Stage	Tree Species	Date Snake Proofed	Outcome
1	A	325	11/23/97	Building	<i>Ficus</i> sp.	11/25/97	Incubation
2	A	326	12/8/97	Platform	<i>Ficus</i> sp.	N/A	Destroyed by typhoon
3	A	327	1/5/98	Early cup	<i>Aglaia mariannae</i>	1/14/98	Incubation
4	A	328	1/22/98	Platform	<i>Ficus</i> sp.	1/22/98	Abandoned
5	A	329	2/8/98	Early platform	<i>Ficus</i> sp.	2/19/98	Incubation
6	B	330	2/11/98	Complete	<i>Drypetes dolichocarpa</i>	N/A	Abandoned
7	C	331	3/5/98	Platform	<i>Tristoropsis obtusangula</i>	3/12/98	Incubation
8	A	332	3/11/98	Platform	<i>Ficus</i> sp.	3/18/98	Incubation
9	B	333	3/16/98	Base/early cup	<i>Guamia mariannae</i>	3/18/98	Abandoned

The Mag 8 Overlook pair was the only other pair known to have built a nest. Their nest was found in the MSA cliffline area on March 11 in *Tristoropsis* tree and was later snake-proofed. A dummy egg was placed in the nest on March 13, after no eggs were laid. Observations revealed that nest attendance was normal. This was the second season the pair was made to incubate a dummy egg. The female was caught, banded, and fitted with a radio transmitter, which unfortunately failed two weeks later.

A pair known as the "11B6" pair probably no longer exists. The banded female was not seen during this breeding season. The male is thought to have remated with the female, "Fadang". This pair made their first and only nesting attempt on February 11. Only a few sticks were placed in the branch of an *Elaeocarpus* tree before the structure was abandoned.

Reproductive success of Mariana crows on Guam has been documented since 1991 (Table 3). The principal cause of the low productivity is infertility probably due to senescence. With the release of Rota crows, a change from no egg-laying activity last season to egg-laying this season was observed. However, the absence of viable eggs continues to be a problem. Although techniques have been developed to control snake predation at nests through snake trapping and electrical barriers, reproductive success can only be improved by releasing young crows from Rota into the Guam's aged crow population.

Table 3. Summary of Mariana crow nesting productivity on Guam from 1990-1998. No eggs were laid during the 1996-1997 season. The eggs laid during the 1997-1998 season were from a pair with a Rota female that was released early in 1997.

Clutch Size	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98
1	4	2	4	1	6	1	0	2
2	0	1	2	2	0	1	0	1
3	0	0	2	4	2	2	0	0
No. of Clutches	4	3	7	7	8	4	0	3
Total Eggs	4	4	12	17	12	9	0	4
Mean Clutch	1.0	1.3	1.7	2.4	1.5	2.3	0	1.3
SD	0.0	0.6	1.0	0.8	0.9	1.0	-	0.6
No. Hatched	0	3	0	3	1	3	0	0
No. Fledged	0	3	0	2	0	2	0	0

RECOMMENDATIONS

1. Continue crow surveys.
2. Continue searches for active crow nests and take appropriate measures to protect them from snake predation.
3. Collect habitat use and reproductive information when crow nests are found.
4. Augment the crow population on Guam with crows translocated from Rota.

PROGRAM COST

The estimated cost of the Mariana crow project under E-2-1 is \$115,000.

LITERATURE CITED

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Report prepared by: Celestino F. Aguon and Lamont Henderson

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-2-1

SUB-PROJECT : A

JOB NO.: 2

JOB TITLE: Area-Wide Control of Brown Tree Snakes (1470)

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Electrical snake barriers were placed on trees at seven of the nine nests built by Mariana crows, *Corvus kubaryi*, during the FY98 breeding season. Six of the nine nests were made by a Rota/Guam pair, two by a Rota/Rota pair, and one by a Guam/Guam pair. Of the four clutches produced during the season, two contained inviable eggs and two were preyed on before the eggs were collected. Of the eight crows released into the wild in FY97, four continue to survive and have mated. The average number of days survived by these eight birds is 298.5 days (SD = 240.9) as of September 30, 1998.

BACKGROUND

Roadside counts by the Guam Division of Aquatic and Wildlife Resources (DAWR) have documented the decline of the native forest birds of Guam (DAWR 1974-1988). Studies by Conry (1988) and Savidge (1987) have indicated that predation by brown tree snake is the main cause of this decline.

Since these studies, attempts to develop effective means of protecting active nests of Mariana crows have been made. Clearing of vegetation in direct contact with the nest tree, snake trapping, use of galvanized sheet metal girdles, and use of the adhesive resin Tanglefoot® have all been used as snake barriers around nest trees. The use of sheet metal girdles and Tanglefoot was partially successful but resulted in the mortality of nest trees and was discontinued. One fledgling was produced from a nest in 1989 as a result of Tanglefoot protection.

Since 1990, active nests have been protected successfully with the use of a combination of electrical barriers placed on the trunks of active nest trees and clearing of vegetation around the tree (Aguon et al. 1992). Successful protection of active nests resulted in the fledging of three crows from two nests in 1992 (DAWR 1992) and two from two nests in 1994 (DAWR 1994). These were the first fledglings in the wild since 1985 (Michael 1987), with the exception of the one produced as a result of Tangle-Foot protection in 1989.

OBJECTIVES

Develop methods for controlling brown tree snake predation on active nests of native birds and apply these methods to protect active crow nests.

PROCEDURES

1. Develop methods for snake-proofing active native forest bird nest sites.

2. Implement snake-proofing methods at Mariana crow nest sites.
3. Efforts to trap unbanded wild crows were made by placing noose traps on feeding platforms and active nests. Noose traps were not left unattended.
4. The crows were instrumented with a 7 or 10 g radio transmitter (see DAWR [1997] for harness design) after they were weighed, measured for wing, tail, tarsus, bill length, and banded with a numbered band (size 4) and a unique combination of color-bands.
5. Crow movements were monitored. For each observation, the date, time, weather conditions (percent cloud cover, wind speed, and presence or absence of rain), habitat type, activity of the bird, species of tree used, location in tree, and height above ground were recorded.
6. Recovered remains of any released birds that died were necropsied to determine possible cause of death. When possible, specimens will be kept for museum purposes as partial skeletons or skins.

RESULTS

Nest Protection

Field use of electrical barriers to protect nests of the Mariana crow from brown tree snake and monitor lizard, *Varanus indicus*, predation continued this fiscal year. The design of this barrier is illustrated in DAWR (1997). This design proved highly effective during field experiments in 1995 (DAWR 1995). Electrical barriers, powered by 12-volt lead acid batteries, were also equipped with solar panels, which lessened the frequency of battery replacement.

Intensive searches were carried out in northern Guam to locate crow territories and nests during the breeding season (approximately November to May). When an active nest was discovered, an electrical barrier was installed on the trunk of the nest tree at night prior to completion of the nest. Night installation was done to avoid undue disturbance to the nesting birds. Installation before completion of the nest allows for the removal of snakes by trapping prior to egg-laying. Trapping for snakes usually involved 10 traps around the nest tree and one in the nest tree. Care and feeding of the mice used as bait in the traps and maintenance of the barrier occurred on a regular basis under the cover of darkness, usually during the early morning hours before sunrise.

Breeding activity improved slightly this year. As a result of the releases of adult crows in FY97 (DAWR 1997), nine nests were built by three pairs. Six of these nests were built by a Rota/Guam pair in the upper Tarague Plateau area. Two clutches of 3 eggs each were collected from this pair, but none of the eggs were viable. One nest had a single egg, and another was destroyed by Supertyphoon Paka in December. Two nests of this pair were preyed on before the eggs could be harvested. In both cases, protective barriers had to be built on horizontal branches, which compromised their effectiveness. Electrical barriers are usually placed on vertical trunks, but because of storm damage to many potential nest trees, this pair nested in trees with horizontal branches. Laboratory tests of barriers placed on horizontal branches need to be conducted to determine potential weaknesses of the design (Table 1).

Table 1. The number of nests found during the 1997-1998 breeding season, with the stage of the nest when found, species of nest tree, and date it was snake-proofed†.

No.	Pair ID	Location	Nest No.	Date Found	Nest Stage	Tree sp.	†
1	Pipeline/Pengua#1	Pipeline	325	11/23/97	Building	<i>Ficus</i>	11/25/97
2	Pipeline/Pengua#2	Pipeline	326	12/8/97	Platform	<i>Ficus</i>	N/A
3	Pipeline/Pengua#3	Tagua	327	1/5/98	Early cup	<i>Aglaia</i>	1/14/98
4	Pipeline/Pengua#4	Pipeline	328	1/22/98	Platform	<i>Ficus</i>	1/22/98
5	Faia/Ahgao	Upper Tarague	330	2/11/98	Complete	<i>Drypetes</i>	N/A
6	Pipeline/Pengua#5	Pipeline	329	2/8/98	Early platform	<i>Ficus</i>	2/19/98
7	Mag 8 Overlook	MSA-pipeline	331	3/11/98	Platform	<i>Tristorops</i> is	3/12/98
8	Pipeline/Pengua#6	Pipeline	332	3/11/98	Platform	<i>Ficus</i>	3/18/98
9	Faia/Ahgao#2	Bowl	333	3/16/98	Base/early cup	<i>Guamia</i>	3/18/98

A Rota/Rota pair (Faia and Ahgao) built two nests, but both were abandoned. Their first was already abandoned when found. The second nest was probably abandoned due to disturbance by hill mynas, *Gracula religiosa*. Two mynas were shot near the nest.

The Mag 8 Overlook pair (a Guam/Guam pair) built a single nest in the Munitions Storage Area (MSA). A dummy egg was placed in the nest to entice the birds to incubate in order to capture the birds. The female was caught, banded, and radio-fitted. Unfortunately, the radio transmitter malfunctioned two weeks later. Prior to capturing the female, the pair had incubated for 20 days. This is the second consecutive season that this pair has accepted and incubated a dummy egg. This suggests that crow pairs that are unable to lay eggs can be enticed to incubate eggs that do not belong to them and thereby act as surrogate parents.

While snake proofing is important in improving the nesting success of crows by preventing snake predation, other additional factors are limiting reproductive success. The lack of breeding activity this season is more evidence of an aging population of crows on Guam. It is recommended that other management techniques be implemented (e.g., translocation of fertile eggs or nestlings from Rota) to improve the reproductive success of these birds.

Movements of Mariana Crows in the Wild

A review of the Mariana crow recovery program was recently completed by the National Research Council (1997). Their recommendations included releasing on Guam all Mariana crows being held in captivity at mainland zoos to help recovery efforts. Of the 12 birds eligible to be released in the 1996-1997 breeding season, two were from the DAWR breeding facility (a male and female), three pairs and a female were from the National Zoological Park Conservation Research Center, and a pair and female were from the Houston Zoo. Eight Mariana crows were eventually released into the wild on Guam during January, March, April, and June 1997, including five from the National Zoo, one from the

Houston Zoo, and the two hand-reared Guam crows. Two crows remain in captivity at the Houston Zoo, while two others died after the report was published.

All crows were fitted with radio transmitters (7 g for females and 10g for males) to monitor their movement. Two 7 g transmitters lasted 90 and 30 days. Two other transmitters were recovered from the field after the birds died. The 10 g transmitters averaged 256 days (SD = 78.65, range = 150-334 days, n = 4).

Of the four remaining crows, Fadang settled the closest (0.64 km) to her release site. After Pengua lost her mate (Kafu) in the MSA, she paired-up with a Guam male, settling 6.02 km from her release site. She made six nesting attempts with this male. Ahgao and Faia, after a brief separation during the early part of their release, paired up again and settled 4.83 km from their release site in the upper Tarague Plateau region. They built two nests in this area, both of which were abandoned.

Survival of Released Crows

Four of the eight crows released in the wild in FY97 (DAWR 1997) continue to survive as of September 30, 1998 (Table 2). These include three females (Pengua, Fadang, and Faia) and a male (Ahgao), which have now existed in the wild an average of 515 days (SD = 45). Survival among the eight released crows has averaged 298.5 days (SD = 240.9) overall (Table 2).

Table 2. The number of days survived by crows released in early 1997. For birds that are still alive, the values are given through September 30, 1998. Transmitters (Tx) weighing 10 g and 7 g were fitted on the birds. † = Release/Nest Distance (km). £ = Type of Tx (g). ∂ = Life of Tx.

	Name	Sex	Survival	†	£	∂
1.	Ahgao	M	476	4.831	10	252
2.	Fadang	F	560	0.642	10	150
3.	Faia	F	476	4.831	10	291
4.	Kafu	M	34 ²		7	46 ³
5.	Nunu	F	63 ¹		7	90
6.	Pengua	F	547	6.024	7 10	30 334
7.	Umumu	F	13 ²			14 ³
8.	Yoga	M	219 ²		10 10	164 ³ 108 ³
	Mean		298.5			
	S D		240.9			

¹Nunu's radio failed after 63 days and her status is unknown.

²The death of these birds was confirmed. ³These radios were still functioning at the time they were recovered.

RECOMMENDATIONS

1. Implement proven methods for protecting nesting Mariana crows.
2. Conduct *in situ* tests of methods which prove effective in laboratory experiments on actual active nest trees.
3. Conduct laboratory tests of the efficacy of electrical barriers on horizontal trunks.
4. Explore the feasibility of area-wide snake control and exclusion of snake from larger areas encompassing nesting territories of crows with the use of barriers.
5. Explore and implement other methods or techniques to improve reproductive success of nesting birds to be used in conjunction with nest protection, i.e., translocation of crows from Rota.
6. Implement recommendations by the NRC for the recovery of the Mariana crow on Guam and Rota.

PROGRAM COSTS

The estimated cost for this project under E-2-1 is \$110,000.

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Report prepared by: Celestino F. Aguon

**JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT**

STATE: Territory of Guam

PROJECT NO.: E-2-1
SUB-PROJECT **:** A
JOB NO.: 3

JOB TITLE: Translocation of Mariana Crows

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Translocation of Mariana crows from Rota to Guam remained on hold pending receipt of a U.S. Fish and Wildlife Service endangered species permit. Written plans for translocation, artificial incubation, hand rearing, releasing of crows on Guam, and area-wide brown tree snake control were completed and submitted, as requested by the Mariana Crow Recovery Team (Aguon 1998a, 1998b).

PROGRAM COSTS

The estimated cost for this project under E-2-1 is \$5,000.

LITERATURE CITED

- Aguon, C.F. 1998a. Translocation, artificial incubation, hand rearing, and releasing Mariana crows. Report submitted to U.S. Fish and Wildlife Service Mariana Crow Recovery Team. Division of Aquatic and Wildlife Resources, Department of Agriculture, Mangilao, Guam.
- Aguon, C.F. 1998b. Area-wide brown tree snake control plan. Report submitted to U.S. Fish and Wildlife Service Mariana Crow Recovery Team. Division of Aquatic and Wildlife Resources, Department of Agriculture, Mangilao, Guam.

Report prepared by: Celestino F. Aguon

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-2-1
SUB-PROJECT.: B
JOB NO.: 1

JOB TITLE: Captive Propagation of Guam Rails and Other Native Species

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

The number of Guam rails, *Gallirallus owstoni*, at the Division of Aquatic and Wildlife Resources' (DAWR) captive breeding facility on Guam increased from 85 on October 1, 1997 to 129 on September 30, 1998. Twenty breeding pairs produced 283 eggs, 118 (42%) of which hatched. One hundred (85%) chicks lived at least 30 days, were banded, and added to the captive flock by September 30, 1998. Fifteen birds were transferred to mainland zoos for breeding purposes, 19 rails were sent to Rota and released in the wild, and 9 rails died. One young rail escaped its holding pen and was not recaptured. Two supertyphoons occurred during the year (Keith on November 2, 1998 and Paka on December 15, 1998), causing the loss of 8 eggs and 1 chick. Five chicks had to be hand-reared due to the typhoons. Two adult mortalities were related to post-typhoon stress.

A Guam Rail Species Survival Plan meeting was hosted by the Zoological Society of San Diego on January 19–21, 1998 and Kelly Brock was elected as species coordinator. Dave Orndorff of the Zoological Society of San Diego was elected as new studbook keeper. The American Zoo and Aquarium Association, Wildlife Conservation Management Committee, confirmed the appointments of Dr. Brock and Mr. Orndorff, and the resignation of Dr. Scott Derrickson as species coordinator and studbook keeper. A Guam Rail Master Plan was distributed in April 1998 as a result of the January meeting.

No Mariana crow, *Corvus kubaryi*, eggs were produced in the wild for artificial rearing in the DAWR's Wildlife Lab. As of September 30, 1998, there were 60 Micronesian kingfishers, *Halcyon c. cinnamomina*, in captivity at mainland U.S. zoos, including 16 viable offspring hatched in FY98.

BACKGROUND

The Guam Native Forest Bird Captive Breeding Program began in 1983 as a cooperative effort between the DAWR, member zoos of the American Zoo and Aquarium Association, (AZA) and the U.S. Fish and Wildlife Service (USFWS) (DAWR 1983, Derrickson 1986, Shelton 1986). Predation by the brown tree snake, *Boiga irregularis*, now believed to be the single most important factor in the recent drastic decline of Guam's native forest birds (Savidge 1986, 1987; Conry 1988), precipitated the need for a captive breeding program when by 1982 at least five species of Guam endemic species or subspecies were nearing extinction in the wild. Unfortunately, by 1984, attempts at captive breeding three of these species, the bridled white-eye, *Zosterops c. conspicillata*, rufous fantail, *Rhipidura rufifrons uraniae*, and the Guam flycatcher, *Miagra freycineti*, were abandoned due to their disappearance from the wild (DAWR 1984).

The Guam rail and Guam subspecies of the Micronesian kingfisher were successfully brought into captivity (DAWR 1983-1986), with the capture of 19 and 31 wild birds, respectively. Rails first bred at the DAWR's facility on Guam and later at the Conservation and Research Center (CRC) of the National Zoological Park during 1984.

Kingfishers were first bred in 1985 at three mainland U.S. zoos (Bronx Zoo, Philadelphia Zoo and the Conservation and Research Center of the National Zoological Park). During FY88, the first studbook for the Micronesian kingfisher was published by the Philadelphia Zoo (Bahner 1989). The kingfisher has been designated as a Species Survival Program species by the AZA. Beth Bahner of the Philadelphia Zoo was designated by the AZA as studbook keeper. The kingfisher program has been relatively successful, as 17 of 29 founders produced descendants (the last previously unrepresented living founder sired offspring in 1994), and the population reached a peak of 62 individuals in August 1990. However, problems such as high chick mortality, high young adult mortality, aggression, and infertility continue to limit population growth (Bahner 1993).

OBJECTIVES

1. Implement and manage captive breeding programs for the Guam rail and other endangered endemic birds by setting up facilities on Guam and at zoos on the mainland U.S. through the AZA.
2. Produce 120 Guam rails for release and establishment of an experimental wild population on Rota, CNMI.
3. Enhance reproductive output of Mariana crows in the wild using avicultural support.
4. Participate in the management of captive Micronesian kingfishers by acting as "field consultant."

PROCEDURES

1. Continue the routine maintenance and operation of a cooperative captive breeding program for the Guam rail and Micronesian kingfisher with the AZA and its member zoos.
2. Continue to consult with recognized authorities regarding captive breeding methodology, facility designs, and captive population management techniques.
3. Consult and coordinate with USFWS, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits.
4. Breed rails in sufficient numbers (120 birds per year) to support the continuing introduction of the Guam rail to Rota, CNMI.
5. Maintain regular contact with the Micronesian kingfisher studbook keeper, and make recommendations to the SSP.
6. Coordinate efforts between field and laboratory for manipulating nests, eggs, and chicks of Mariana crows in the wild.

RESULTS

There was increase of 44 Guam rails at the DAWR's captive breeding facility during FY98. The high number of offspring produced (100 birds) likely resulted from a doubling of the number of pairs producing offspring as compared to previous years and getting young birds paired up early. In the 1st quarter of FY98, the average age of males was 5.7 years and the average age of females was 4.9 years ($n = 9$ pairs). The average age of birds added to the breeding cohort in the 2nd – 4th quarters was 3.1 years for males (although skewed from 2.3 years because of a trial with an 11-year-old male) and 1.5 years for females ($N = 11$ pairs). Although 20 pairs produced eggs, 3 pairs produced no offspring. One unsuccessful pair produced inviable eggs (5 of 7 eggs resulted in embryonic death, while the other 2 disappeared from nest). Two unsuccessful pairs produced 35 infertile eggs and 2 inviable eggs that resulted in early embryo death, probably due to the advanced age of the males (9 and 11 years) or pair incompatibility. The female of one infertile pair was repaired with a younger male and subsequently produced offspring.

Nineteen rails were transferred and released on Rota, and nine adult rails died at the DAWR captive breeding facility. Two supertyphoons passed Guam in FY98. Supertyphoon Keith passed on November 2, during which 12 eggs were pulled from 4 nests for artificial incubation. None of the eggs hatched. On December 15, Supertyphoon Paka hit Guam directly, during which 9 eggs were pulled from 4 nests for artificial incubation. One egg hatched. Also during Paka, 5 chicks were pulled for hand-rearing, one of which later died due to storm related trauma. In all, 5 chicks were hand-reared due to typhoons. Just prior to Paka, all rails were brought inside the Wildlife Lab for protection (this was not necessary during Keith) and held for 48 hours. Upon release back into their pens, one weakened female died within an hour and a second female died about a week later. The second death may also be attributed to post-typhoon stress between her and her mate. No significant damage occurred to rail pens during either typhoon, although the perimeter fence was heavily damaged during Paka.

In January 1998, a Guam Rail Species Survival Plan meeting was hosted by the Zoological Society of San Diego. The objectives of the meeting were to update the Guam rail studbook, review the status of the zoo population of Guam rails, update the zoo community on the activities of DAWR, and develop a master plan for the revitalization of the zoos' captive breeding component of the rail program. The Guam Rail SSP Master Plan was distributed in April 1998 and contained recommendations for the transfer of Guam rails from Guam to five zoos for breeding purposes. Fifteen rails were transferred from Guam to four of those zoos (San Diego Zoo, San Antonio Zoo, Audubon Zoo, and Cincinnati Zoo). The rail population at the zoos was approximately 50 rails (including the transferred birds) and breeding pairs were reestablished. Five rails were hatched and reared to >30 days old in the zoos. At the SSP meeting, Dr. Scott Derrickson suggested that Kelly Brock of the DAWR take over as SSP coordinator. David Rimlinger (Curator of Birds, San Diego Zoo) nominated his staff member, David Orndorff (lead bird keeper) to be studbook keeper. The SSP group unanimously agreed. The changeover was formalized by the Wildlife Conservation and Management Committee of the AZA. A follow-up SSP meeting was held at the annual AZA conference in Tulsa, Oklahoma, in September 1998.

Reproduction of Mariana crows in the wild continued to be zero in FY98. No eggs were produced by any crows for natural or artificial rearing.

Micronesian kingfishers continued to be captive bred at 8 mainland U.S. zoos, with total numbers increasing to 60 birds. Eight viable offspring were reared at the San Diego Zoo, three at the Brookfield Zoo in Chicago, two at the Lincoln Park Zoo in Chicago, and two at the Houston Zoo. Two offspring were successfully parent-reared (one at San Diego Zoo

and one at Houston Zoo). Several organizations, including the USFWS, awarded grants to Dr. Susan Haig at Oregon State University for her proposed field study of Micronesian kingfishers in Pohnpei. This project is expected to start in FY99.

RECOMMENDATIONS

1. Continue the routine maintenance and operation of a cooperative captive breeding program for the Guam rail and Micronesian kingfisher with the AZA and its member zoos.
2. Continue to consult with recognized authorities regarding captive breeding methodology, facility design, and captive population management techniques.
3. Consult and coordinate with USFWS, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits for shipment of rails between Guam and mainland U.S. zoos.
4. Breed rails in sufficient numbers to support the continuing introduction of the Guam Rail to Rota, Commonwealth of the Northern Mariana Islands.
5. Coordinate with all SSP participants for the transfer of Guam rails produced in zoos for Guam for the purposes of captive breeding at the Guam facility or for release on Rota.
6. Continue avicultural intervention of Mariana crows and support efforts of DAWR to increase production of crows in the wild through efforts to snake-proof crow nest sites.
7. Initiate plans for the repatriation of Micronesian kingfishers to the captive breeding facility on Guam. Apply for outside funding for the proposed kingfisher captive management facility at the Guam Department of Agriculture.

PROGRAM COSTS

The estimated cost for this project under E-2-1 is \$120,000.

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This report was prepared by: M. Kelly Brock.

**JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT**

STATE: Territory of Guam

PROJECT NO.: E-2-1
SUB-PROJECT .: B
JOB NO.: 2

JOB TITLE: Mariana Crow Avicultural Support

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

No avicultural support was implemented under this project, pending receipt of a U.S. Fish and Wildlife Service endangered species permit to translocate Mariana crows from Guam to Rota. As requested by the Mariana Crow Recovery Team, written plans for translocation, artificial incubation, hand-rearing, and releasing Mariana crows and area-wide brown tree snake control were completed and submitted (Aguon 1998).

PROGRAM COSTS

The estimated cost for this project under E-2-1 is \$5,000.

LITERATURE CITED

Aguon, C.F. 1998. Translocation, artificial incubation, hand rearing, and releasing Mariana crows. Report submitted to U.S. Fish and Wildlife Service Mariana Crow Recovery Team. Division of Aquatic and Wildlife Resources, Department of Agriculture, Mangilao, Guam.

Report prepared by: Celestino F. Aguon.

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-2-1
SUBPROJECT.: B
JOB NO.: 3

JOB TITLE: Captive Propagation of Guam Micronesian Kingfishers

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

As of September 30, 1998, there were 60 Micronesian kingfishers, *Halcyon c. cinnamomina*, in captivity at mainland U.S. zoos, including 16 viable offspring hatched in FY98. Plans are being developed to begin captive breeding kingfishers on Guam.

BACKGROUND

The Guam Native Forest Bird Captive Breeding Program began in 1983 as a cooperative effort between the Division of Aquatic and Wildlife Resources (DAWR), member zoos of the American Zoo and Aquarium Association, (AZA) and the U.S. Fish and Wildlife Service (USFWS) (DAWR 1983, Derrickson 1986, Shelton 1986). Predation by the brown tree snake, *Boiga irregularis*, now believed to be the single most important factor in the recent drastic decline of Guam's native forest birds (Savidge 1986, 1987; Conry 1988), precipitated the need for a captive breeding program when by 1982 at least five species of Guam endemic species or subspecies were nearing extinction in the wild. Unfortunately, by 1984, attempts at captive breeding three of these species, the bridled white-eye, *Zosterops c. conspicillata*, rufous fantail, *Rhipidura rufifrons uraniae*, and the Guam flycatcher, *Miagra freycineti*, were abandoned due to their disappearance from the wild (DAWR 1984).

Kingfishers were first bred in 1985 at three mainland U.S. zoos (Bronx Zoo, Philadelphia Zoo, and the Conservation and Research Center of the National Zoological Park). During FY88, the first studbook for the Micronesian kingfisher was published by the Philadelphia Zoo (Bahner 1989). The kingfisher has been designated as a Species Survival Program species by the AZA. Beth Bahner of the Philadelphia Zoo was designated by the AZA as studbook keeper. The kingfisher program has been relatively successful, as 17 of 29 founders produced descendants (the last previously unrepresented living founder sired offspring in 1994), and the population reached a peak of 62 individuals in August 1990. However, problems such as high chick mortality, high young adult mortality, aggression, and infertility continue to limit population growth (Bahner 1993).

OBJECTIVES

1. Participate in the management of captive Micronesian kingfishers by acting as a "field consultant".
2. Develop plan for captive breeding Micronesian kingfishers on Guam.

PROCEDURES

1. Continue routine maintenance and operation of a cooperative captive breeding program for the Micronesian kingfisher with the AZA and its member zoos.
2. Continue to consult with recognized authorities regarding captive breeding methodology, facility designs, and captive population management techniques.
3. Consult and coordinate with USFWS, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits.
4. Maintain regular contact with the Micronesian kingfisher studbook keeper and make recommendations to the SSP.

RESULTS

Micronesian kingfishers continued to be captive bred at 8 mainland U.S. zoos, with total numbers increasing to 60 birds. Eight viable offspring were reared at the San Diego Zoo, three at the Brookfield Zoo in Chicago, two at the Lincoln Park Zoo in Chicago, and two at the Houston Zoo. Two offspring were successfully parent-reared (one at San Diego Zoo and one at Houston Zoo). Several organizations, including the USFWS, awarded grants to Dr. Susan Haig at Oregon State University for her proposed field study of Micronesian kingfishers in Pohnpei. This project is expected to start in FY99.

Planning continued for the development of a captive breeding program for Micronesian kingfishers on Guam.

RECOMMENDATIONS

1. Continue routine maintenance and operation of a cooperative captive breeding program for the Micronesian kingfisher with the AZA and its member zoos.
2. Continue to consult with recognized authorities regarding captive breeding methodology, facility designs, and captive population management techniques.
3. Consult and coordinate with USFWS, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits for shipment of kingfishers between Guam and mainland U.S. zoos.
4. Initiate plans for the repatriation of Micronesian kingfishers to the captive breeding facility on Guam. Apply for outside funding for a proposed kingfisher captive management facility at the Guam Department of Agriculture.

PROGRAM COSTS

The estimated cost for this project under E-2-1 is \$5,000.

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Report prepared by: M. Kelly Brock

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-2-1
SUBPROJECT: C
JOB NO.: 1

JOB TITLE: Development of an Experimental Population of Guam Rails in the Commonwealth of the Northern Mariana Islands

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Nineteen (12 males, 7 females) Guam rails (*Gallirallus owstoni*) were released at the Sagua'gagha area of Rota on June 17. Twelve of the rails (5 males, 7 females) were released into a 2.5 ha forest enclosure, while 2 breeding pairs were released in separate 25 m² holding pens. Extensive efforts were made to remove predators from the general release area. All birds were instrumented with radio transmitters. Mortality was 47%, as nine rails were confirmed dead. One rail (5%) survived to the end of the monitoring period. Eighty-four percent (n=16) of the birds escaped the enclosures during the monitoring period. There was a problem with some of the rails breaking off their antennas. Rails that escaped the enclosure dispersed widely from the release site, with the longest documented distance being 5.4 km. Sixteen rails remained in the enclosures a mean of 9.7 days (range = 1-36 days) before escaping. Rails used supplemental feeding stations set inside the enclosure, which facilitated observation of birds from blinds set near the stations. Work continued on the rail project this year despite a failure to renew a Memorandum of Agreement between Guam, the U.S. Fish and Wildlife Service (USFWS), and the Commonwealth of the Northern Mariana Islands (CNMI).

INTRODUCTION

Census data collected between 1960 and the early 1980s documented the reduction in range and numbers of the Guam rail (Wittelman et al. 1990). In 1984, only about 20 rails were known to remain in the wild and the species was added on the U.S. Endangered Species List. In 1982, the DAWR decided to develop a captive breeding program for the Guam rail and by 1986, all known remaining rails were collected (n = 21). The extirpation of the Guam rail from the wild was due primarily to predation pressure from the introduced brown tree snake (*Boiga irregularis*). The captive propagation program was organized under the auspices of the American Zoo and Aquarium Association (AZA) and presently includes the cooperation of 18 mainland zoos. The rails demonstrated an immediate propensity for breeding in captivity and to date over 400 rails have been produced in captivity (Derrickson 1996).

The captive management of the Guam rail uses the metapopulation approach, which calls for the establishment of more than one subpopulation (Foose et al. 1986). This has been accomplished by dispersing the captive rails into two primary captive populations on Guam and in U.S. zoos. Because reintroduction of the Guam rail to part of its historical range on Guam is a recovery objective, the establishment of an experimental wild population on snake-free Rota was proposed (USFWS 1989), to serve as a third genetic reservoir to prevent genetic drift and inbreeding, and to ensure the maintenance of behavioral

adaptations for the wild. Reintroductions of captive produced animals are less likely to succeed than translocations of wild-caught animals because of behavioral deficits (Griffith et al. 1989). Experience gained in releasing Guam rails on Rota will provide valuable information, and perhaps birds, useful for future reintroductions.

OBJECTIVES

1. Establish a non-essential, experimental wild population of the Guam rail in suitable snake free habitat on Rota, CNMI.
2. Release up to 120 captive-produced rails per year from the propagation facility of the Division of Aquatic & Wildlife Resources (DAWR) to initiate establishment of rails on Rota.
3. Release captive-produced rails from the propagation facilities of cooperative mainland zoos to initiate establishment of rails on Rota.
4. Monitor survival, dispersal, reproduction and establishment of released rails through radio telemetry.
5. Construct a temporary, large scale, enclosure to reduce dispersal, increase site fidelity, and increase the chances of successful nesting and reproduction.
6. Sign a new cooperative agreement with the CNMI and USFWS to continue the introduction program on Rota.

PROJECT HISTORY

In 1987, a Memorandum of Understanding was signed between the Government of Guam, CNMI, and USFWS for the establishment of an experimental population of Guam rails on snake-free Rota. An environmental assessment was prepared for the USFWS covering the introduction of the Guam rail to Rota. The DAWR reached an informal agreement with Dr. Stuart Pimm, University of Tennessee, and by which a graduate student resided on Rota to monitor the initial two rail introductions in cooperation with the DAWR as a part of his dissertation research. Dr. Pimm was successful in receiving several grants from international conservation organizations to support efforts to monitor the introductions on Rota.

After a permit to establish an "non-essential experimental population" of Guam rails on Rota was published (USFWS 1989), 22 rails were released at a site on the Sabana on Rota in December 1989 and January 1990. All but one rail were released with radio transmitters attached in order to monitor their dispersal, mortality and possible breeding success. The site proved to be unsatisfactory probably due to the presence of dense grassland habitat. Of the 22 released birds, the whereabouts of 9 were unknown as their radios failed, 4 were killed by vehicles, 2 were killed by cats, 2 apparently died of starvation, 1 died of poisoning, and 4 died of unknown causes (Witteman et. al. 1990, DAWR 1991).

In February 1991, 31 rails were released at the forest edge in I Chenchon Park near the Bird Sanctuary Overlook (Witteman and Beck 1991). This release appeared to be more successful than previous ones. Releases were discontinued until the spring of 1995 due to the low production of rails at captive breeding facilities.

Beginning in 1995, the release site was moved further inside the forest to the east from the 1991 release site (Figure 1). So far, 167 rails have been released on Rota, 21 in December

1989, 33 in February 1991, 15 in March 1995, 30 in August 1995, 15 in September 1995, 15 in April 1996, 19 in April 1997 and 19 in June 1998. Extensive efforts were made to remove predators from the release area. Successful breeding by captive-reared Guam rails released on Rota was documented in December 1995 following the release of 45 birds in a 6-week period. The pair that reproduced stayed within the predator controlled release site, and the male was observed escorting a 3 week-old chick to a supplemental food station. The male and chick were captured in a cat trap in January 1996, but have not been seen since.

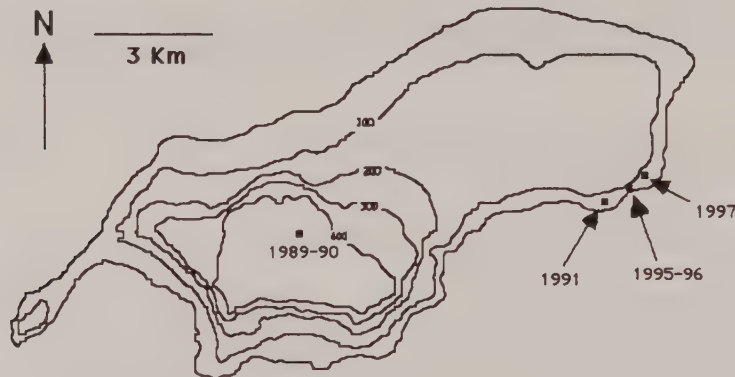


Figure 1. Locations of rail release sites (1989-90) in Rota, CNMI. Black squares indicate release site locations.

METHODS

Study Site Description

The release area is a coastal limestone cliff area located on the eastern end of the island on a narrow shelf of native limestone forest bound by upper and lower limestone cliffs. South of the shelf and bordering the ocean is a large seabird nesting colony. The remaining area is a mixture of native forest pockets, scrub (secondary growth), and clearings with coconut plantings.

Release Method

In an effort to reduce mortality and dispersal, increase site fidelity, and increase the chances of successful nesting and reproduction, a temporary 1.6-ha enclosure was constructed in the eastern end of the former release area. The enclosure was constructed of 6 ft high 1 inch chicken wire and was tacked to trees in the forest using staples, wire, and plastic ties. Rails were shipped to Rota via commercial airplane. Nineteen rails (12 males, 7 females) were released on June 17, 1998 inside the enclosure. Two smaller 5 m x 5 m pens were also constructed approximately 400 m west of the large enclosure. These smaller pens were for holding two pairs of rails, one pair of which had successfully bred in captivity. All birds had serially numbered aluminum bands on the right leg and were equipped with backpack-mounted radio transmitters.

Predator Control

As many as 18 live traps were set along the trail in the release area to control feral cat (*Felis domesticus*) and monitor lizard (*Varanus indicus*) populations. Trap numbers set varied

due to some of the traps being periodically stolen. Cat traps were placed 100-200 m apart along the trail for a distance of about 2 km. Canned cat food was used as bait. Traps were set for capture all day as monitor lizards were also targeted for capture. Following capture of a cat or monitor lizard, the animal was killed with a pellet gun, weighed, measured, classified to age and sex, and its gut contents checked for remains of rails.

Radiotelemetry

All 19 rails were equipped with backpack mounted radio transmitters (Holohil Systems Ltd.). Radio-marked birds were relocated using a Telonics TR-2 portable receiver/scanner and a hand-held antenna. Locations of radio-marked rails were recorded according to the station (every 25 m along the main trail) to which they were the closest. If rails dispersed out of the release area and away from the trail, general topographical and geological features were used to describe the bird's location. Birds were never flushed to avoid disturbing potential nesting pairs or broods and driving the birds from the release area. Data were collected on survivorship, mortality, and dispersal. Two aerial searches were made from a Cessna 185 operated by Freedom Air to locate dispersed birds whose radio signals could not be found in ground searches. On both occasions, staff from the Rota DLNR Division of Fish and Wildlife accompanied DAWR staff in the aircraft.

Supplemental Feeding

Supplemental food stations were set up inside the enclosures and in the release area in an attempt to get the rails to stay in the release area. The food (captive diet) was presented in the same manner on Rota as it was in captivity on Guam. Every morning, fresh food was put in a plastic dish under a tent of aluminum and wood to protect it from rain. Once it was determined that a station was being used, a temporary blind was placed near the station to visually monitor the birds. Feeding and mating behaviors were recorded.

RESULTS

Predator Control

Nine cats (9 males) and 1 monitor lizard were caught during 888 trap nights during FY98 (4.85 cats/1,000 trap nights, 0.54 monitors/1,000 trap nights).

Mortality, Survival, and Dispersal

Mortality of released rails was 47%, with nine birds confirmed dead (Table 1). Six of these deaths were due to cat predation. Two additional birds had mortality signals turn on, but the transmitters were unrecoverable. One bird was scavenged and its cause of death was unknown, while another bird also died of unknown causes. One death was attributed to an infection (acute hemorrhagic bacterial enteritis).

Only one rail (5%) is known to have survived to the end of the monitoring period. Eighty-four percent (n=16) of the birds escaped the enclosures during the monitoring period. There was a problem with some of the rails snapping off their antennas. This may contribute to difficulties associated with locating lost birds. Rails that escaped from the enclosure moved a mean distance of 1,167 m (range 75-5,400 m) from the release site. Rails (n=16) remained in the enclosures a mean of 9.7 days (range = 1-36 days) before escaping (Table 1).

Rails used supplemental feeding stations set inside the enclosure, which allowed birds to be observed from blinds set near the stations. Two of the 5 feeding stations were used regularly.

Table 1. Movements, survival, and mortality of rails released on Rota, CNMI on June 17, 1998. Δ = # days survived through 9 September. $\dagger$ = # of days in pen before escape. $\pounds$ = # of days survived after escape. $\boxtimes$ = distance moved after escape/release (m).

Freq	Sex	Δ	$\dagger$	$\pounds$	$\boxtimes$	Fate
365	M	16	15	1	450	Dead 7/3. Probable cat predation.
608	F	97+	—	—	—	Alive in pen as of 9/9.
658	M	5	2	3	1700	Dead 6/22. Cat predation.
620	F	72+	72	—	—	Missing from pen as of 8/28.
871	M	11	9	2	450	Dead. Scavenged in seabird colony 6/28.
699	M	2+	1	1+	625	Missing as of 6/19.
579	M	21	17	4	500	Dead 7/8. Cat predation.
790	F	36	2	34	575	Dead 7/23. Cause of death unknown.
596	M	9	8	1	450	Dead 6/26. Probable cat predation.
688	F	48	1	47	825	Dead 8/4. Probable cat predation.
183	M	—	—	—	—	Missing. Broken antenna at release.
396	F	12	2	10	3375	Mortality signal 6/29. Not recovered.
937	M	21+	21	—	125	Missing. Broken antenna.
958	M	9	4	5	450	Dead 6/26. Bacterial infection.
040	M	36+	35	1+	1450	Missing. Alive 7/23 from air.
739	M	7	3	4	1525	Dead 6/24. Probable cat predation.
719	F	16	12	4	75	Mortality signal 7/3. Unrecoverable.
913	F	42	21	21	5400	Missing since 7/29.
386	M	7	1	6	700	Missing since 6/24.

DISCUSSION

A total of 9 male cats were trapped this fiscal year (4.85 cats/1,000 trap nights). This is an increase over the capture rates in 1997 (3.56 cats/1,000 trap nights) and 1996 (3.90 cats/1,000 trap nights), but is less than the 1995 rate (7.86 cats/1,000 trapnights). The increase in capture rate and the high number of deaths contributed to feral cat predation ($n=6$) in 1998 may be an indication that the birds dispersed more widely and out of the effective cat trapping area. Indeed, mean dispersal increased for birds that escaped from the enclosure from 756 m in 1997 to 1,167 m in 1998. The drought that affected the area in 1998 after Supertyphoon Paka may have contributed to the birds and cats dispersing farther in search for food and water. It is advisable to continue trapping for feral cats and to periodically relocate traps to minimize the chances that cats may habituate to their locations. Supplementary food and water should also be placed out for the rails, especially during periods of dry weather, to help minimize dispersal and increase survival. It is also advisable to increase the cat trapping effort by either increasing the number of traps, by actively hunting cats at night, or both.

Only one monitor lizard was captured in cat traps during 1998 (0.54 lizards/1,000 trap nights), down from two animals in 1997 (1.62 lizards/1,000 trap nights) and 10 animals in 1996 (3.90 lizards/1,000 trap nights). Although the traps are biased toward medium-sized monitor lizards (they exclude very small and very large lizards), the decrease in the number of monitors captured may be an indication that trapping is effective in keeping their numbers down. Although there is no direct evidence that monitor lizards prey on adult rails, chicks, or eggs, they are a potential predator of all of these. Continuing to trap and remove monitor lizards from the area is advisable.

No rat trapping was conducted in 1998 due to time constraints associated with constructing the enclosures and the possibility that traversing a rat trapping grid on a daily basis might disturb the rails. Although there is no evidence to show that rats have depredated rail nests or chicks, rats are still a potential predator of both. Based on personal observation, the

density of rats in the release area is extremely high. Conducting rat trapping prior to release and then discontinuing it once the birds have been released may reduce the density of rats in the enclosure without disturbing the rails.

The 2.5 ha enclosure constructed in the release area was not successful in increasing the survival of the birds as 84% (n=16) escaped during the monitoring period. Of the 16 birds that escaped, none lived to the end of the monitoring period. Mean survival once outside the enclosure was 10.9 days (23.2 days for females, 3.25 days for males). However, one female survived at least 97 days inside the enclosure to the end of the monitoring period. Birds stayed in the pen an average of 9.7 days before escaping. As previously mentioned, dispersal from the release site increased from 756 m in 1997 to 1,167 m in 1998.

The fence successfully protected the one rail that stayed in the enclosure from feral cats, whereas at least six of the rail deaths outside the enclosure were attributed to cat predation. Also, one bird released in 1997 (band #10305) was found in the gut of a cat trapped on 13 November 1997.

An attempt was also made to house previously paired birds in separate release cages (5 m x 5 m). The male of each pair escaped after 1 and 3 days, respectively, of being put in their enclosures, thus the decision was made to immediately release the females inside the larger enclosure. Both of these males died within 6 days of escaping. The small enclosures hold promise for keeping paired birds for breeding purposes. They may help to reduce dispersal and mortality, provided the rails don't escape from the enclosure. The enclosures may also need to be made larger to accommodate breeding pairs. A larger enclosure may help to reduce stress and give the birds more room to roam, forage, find adequate nesting sites, and hide from the investigator when food and water is brought daily.

Survivorship may be partially dependent on supplemental feeding as rails that escaped from the enclosure did not live as long as rails that remained in the enclosure and used supplemental food stations. Only one rail stayed inside the enclosure for the entire 97-day monitoring period. Supplemental food stations may have played a role in defining (or defending) territories inside the enclosure. This may be the reason why 84% of the birds escaped from the enclosure. There may not have been enough resources for the number of birds inside the enclosure, and the birds may have been forced out to find resources due to the dry weather. It is advisable to supply food and water for the birds while they are in enclosures to reduce dispersal and increase survival.

Some of the lost signals may be attributed to birds breaking their antennas at the base. This problem has been fixed for future releases as the base of the antennas have been reinforced with an extra layer of rubber coating and a spring.

The two aerial surveys were useful in finding birds that had dispersed from the release area. Aerial surveys should be continued to locate those birds that have dispersed from the release area or are in areas inaccessible on foot.

CURRENT STATUS OF PROGRAM

The first release in FY98 was scheduled for April 1998. However, the November 1997 general elections resulted in changes with the Rota mayor and staff at the Department of Land and Natural Resources on Rota, and consequently delayed the rail project. The new mayor expressed his desire to have local residents benefit in some way from the rail project and requested that at least one resident be employed on the project. While the possibilities of providing such employment were being investigated, the mayor allowed a "good faith" release of Guam rails to take place in June 1998. No further releases took place during the reporting period. A renewed Memorandum of Agreement between Guam, the CNMI, and

the USFWS was still not signed as of September 30, 1998. Biologist Grant Beauprez returned to Guam from Rota on September 30, 1998.

RECOMMENDATIONS

1. Continue to trap and remove feral cats and monitor lizards from Sagua'gahga forest and surrounding areas.
2. Attach radio transmitters to all released birds to obtain more data regarding dispersal, mortality, and reproduction.
3. Investigate ways to improve the enclosure to reduce the escape rate of rails.
4. Investigate the possibility of changing the release site or releasing some birds to an area where dispersal may be limited
5. Continue to release cohorts of 15-20 birds minimum, every 3-6 months until the birds become established. Attempt to release at least one mated pair in each cohort.
6. Continue periodic aerial surveys to find radio-marked birds that may have dispersed from the release area.
7. Continue the use of supplemental feeding stations as this may help to reduce dispersal and facilitates observation of birds.

PROGRAM COSTS

The estimated cost for this project under E-2-1 is \$90,000.

ACKNOWLEDGEMENTS

The DFW staff on Rota was extremely helpful in supplying manpower and vehicles. Conservation officers assisted in carrying the rails and fencing into the forest. Division biologist Stan Taisacan assisted in various aspects of the program, including transportation and office support. USFWS biologists provided assistance by monitoring released rails.

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Report prepared by: Grant M. Beauprez and M. Kelly Brock

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-2-1
SUBPROJECT NO.: D
JOB NO.: 1

JOB TITLE: Establishment of Populations of Endangered Species in Snake-Free Areas on Guam

PERIOD COVERED: October 1, 1997 to September 30, 1998

SUMMARY

Area 50 was selected as the initial Guam reintroduction site for Guam rails (*Gallirallus owstoni*) following their extinction from the wild in the 1980s. To prepare for the rail release, the brown tree snake (*Boiga irregularis*) population had to be substantially diminished in Area 50. A large-scale test of Engeman's perimeter trapping theory was carried out, the efficacy of which was substantiated by declining snake population estimates from mark-recapture surveys before and after the perimeter trapping treatment. A snake barrier was installed and a method to partially monitor immigration and emigration has been employed. Interior snake removal will continue as snakes mature into a trappable size, breach the barrier, or are otherwise captured. A larger scale operational test of perimeter trapping was initiated in the nearby Munitions Storage Area (MSA) to begin preparation of this area for the release of Mariana crows (*Corvus kubaryi*) translocated from Rota. At the request of the Mariana Crow Recovery Team, an area-wide snake control plan was formulated using the barrier and trapping techniques developed in field research at Area 50 and MSA.

BACKGROUND

A 24-ha area of limestone forest, known as Area 50, located in Northwest Field, an abandoned World War II airfield located on Andersen Air Force Base, was set aside by the Air Force in 1991 as a test area for restoration of natural ecosystems. Area 50 is surrounded by tarmac taxiways and was completely fenced with a six-foot cyclone fence to exclude deer and feral pigs. In early 1997, the area was selected as a potential site for the release of captive-bred Guam rails. Plans were developed to make the area relatively snake-free in preparation for the rail release, using trapping and barrier technology.

Initial surveys were conducted on the vegetative community and lizard and rodent populations of Area 50. A mark-recapture estimate of brown tree snakes was conducted in June 1997 to estimate the pre-treatment population of snakes. A 10x14 trap grid (140 traps), using mouse-baited traps at 40-m spacing, was activated until the recapture percentage (of total captures) exceeded 50%. In 30 nights of trapping, a total of 313 snakes was caught, tagged, and released. The preliminary population estimate was 365 snakes (95% CI=288-463).

Because of the encouraging results in evaluating perimeter trapping in smaller areas elsewhere on Guam (Engeman et al. 1997), it was decided to test this technique on an operational scale in Area 50 prior to installation of the planned snake barrier. In September 1997, 52 traps were installed on the perimeter fence, spaced at 40-m intervals alternating with the traplines of the interior grid.

OBJECTIVES

1. Test the efficacy of perimeter trapping on an operational scale.
2. Reduce and maintain the snake population in Area 50 to levels tolerable for a sustainable Guam rail population.
3. Reduce the snake population in selected areas of the MSA in preparation for release of Mariana crows translocated from Rota.

PROCEDURES

Area 50

First Mark-Recapture - In June 1997, an interior grid of 140 traps was activated inside of Area 50. In all mark-recapture surveys, captured snakes were marked with an electromagnetically labeled passive integrated transponder (PIT) tag for identification. The pre-treatment brown tree snake population was estimated.

Perimeter Trapping - From September 1997 until late February 1998, fenceline traps and the 44 outermost traps of the interior grid were operated, with all captured snakes removed. Trap numbers, snout-to-vent lengths (SVL), total lengths, sexes, masses, and PIT tag numbers were recorded for each snake. Databases have been maintained on individual snake capture/recapture histories.

Second Mark-Recapture - In late February 1998, fenceline traps were deactivated and the interior grid reactivated for another mark-recapture estimate of density. This mark-recapture exercise was terminated in late March and removal trapping began with the trap grid.

Immigration and Emigration - In late January 1998, mark-recapture trapping was initiated with 25 traps installed at 40-m intervals along the forest edge across from the tarmac bordering the north and east sides of Area 50 to detect immigration into or emigration from Area 50.

Barrier Installation - A snake barrier based on a design developed by USGS Biological Resources Division was retrofitted to the chainlink fence surrounding Area 50. The barrier was constructed of 1/4 inch galvanized hardware cloth (wire mesh). It was fastened to the tarmac and extends to the top of the six-foot chain-link fence. The barrier has a semi-circular bulge near the top. The interior trapping grid continues to be operated and is combined with nocturnal visual searches on the fence and in the forest interior.

MSA

In June 1998, 112 snake traps were activated around the perimeter of a 41.5 ha area in the nearby MSA. This area contains several potential release sites of Mariana crows translocated from Rota.

RESULTS

Area 50

A total of 430 snakes was removed by perimeter trapping, 174 of which were recaptures from the 1997 mark-recapture exercise. The weekly capture rate dropped from 100 in the first week (1.04 snakes per trap-week) to nearly zero by mid-December 1997.

During 30 nights of the post-treatment mark-recapture effort, only 30 individual snakes were captured, with no more than one recapture in any day. Only 25% of the total captures were recaptures, thus a statistically reliable population estimate was not possible.

As of September 30, 135 snakes had been removed from Area 50 by grid trapping. Thirty-seven of those snakes were marked and released during the first or second mark-recapture studies. A total of 565 snakes have been removed from Area 50 since initiation of perimeter trapping in September 1997, inclusive of these grid-trapping results. An additional 125 snakes were marked, but not yet recaptured. Removal trapping continues to date, and the capture rate has dropped to about 4 snakes per week.

An indication that perimeter trapping has significantly reduced the snake population in Area 50 is that although no rats were detected in a small mammal survey made in 1997, rats began to appear in snake traps in January 1998 and 12 rats were caught when the small mammal survey was repeated in 1998. A total of 24 rats were captured in snake traps from February 27 to September 30.

Immigration and Emigration - A total of 78 snakes were marked and released from traps across the tarmac from Area 50 as of September 30. To date, seven of those snakes have been recaptured inside Area 50, but no emigration from Area 50 has been detected. During the early part of the perimeter trapping phase, another snake was captured in Area 50 that had been originally marked and released three years earlier at a location 2.1 km north of Area 50.

MSA

The capture rate in MSA declined in an exponential fashion similar to Area 50, dropping from 160 snakes in the first week (20.4 snakes/100 trap nights) to fewer than 40 snakes (5 snakes/100 trap nights) by mid-July. At the end of the reporting period, the capture rate had stabilized at about 20 snakes per week (2.5 snakes/100 trap nights).

At the request of the Mariana Crow Recovery Team, an area-wide snake control plan has been formulated using the barrier and trapping techniques developed in field research at Area 50 and MSA.

RECOMMENDATIONS

Snake population monitoring and removal will be necessary after the introduction of Guam rails. Snakes continue to recruit into the trappable population as eggs hatch and juvenile snakes mature. Monitoring may include perimeter trapping on the inside of the fence and/or the outermost row of grid traps, periodic activation of the interior trapping grid, and periodic nocturnal visual searches in the forest interior.

The results of perimeter trapping around Area 50 and MSA are encouraging and suggest that a significant area-wide reduction of brown tree snakes may be possible using perimeter trapping alone (DAWR 1998). The key may be discrete areas defined by roads so access is reasonably facilitated. Numerous such areas are found island-wide, particularly in urban areas.

From the endangered species recovery standpoint, these results are very encouraging. Many similar discrete areas of important endangered species habitat are located on Andersen Air Force Base. The MSA, for example, has a network of roads around blocks of forest that are generally half as wide as Area 50. Similar areas occur at Naval Ordnance Annex.

It seems feasible for the perimeters of selected blocks of forest to be routinely trapped as described above. Based on the DAWR's results to date, a 2-person team should be able to service about 125 traps per day. If the traps are visited only once per week, that 2-person team should be able to service as many as 625 traps during a 5-day workweek. If the traps are spaced at 40 m intervals, a total perimeter of up to 25 km could be covered in a 5-day workweek (Anderson et al. 1998).

Examination of a map of the MSA reveals three similar sized blocks, each subdivided into smaller units averaging only 125-150 m in width (in contrast, Area 50 is 400 m wide). Each of these larger blocks contains a total forest perimeter of about 25 km, suggesting that nearly the entire MSA could be continuously trapped by three or four 2-person snake trapping teams.

It is likely that the snake capture rate in the MSA would decline at a more accelerated rate than seen in Area 50 because the blocks of forest are of smaller area. As the snake population is reduced and capture rates decline, the trapping teams may be able to handle increasing numbers of traps, allowing expansion of trapping efforts into additional areas.

Implementation of such an intensive perimeter-trapping program in the MSA or at Ordnance Annex could be accomplished by broadening the scope of the USDA Wildlife Services mandate from the military. In addition to directly benefiting endangered species recovery on Guam, which is a statutory responsibility of federal agencies, a reduction in brown tree snake populations in these areas would also reduce the probability of snakes entering the transportation system via shipments of ordnance and military equipment, or through training exercises.

PROGRAM COSTS

The estimated cost for this project under E-2-1 is \$80,000.

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Report prepared by: Allan D. Searle and Robert D. Anderson

APPENDIX 1

LIZARD TRAPPING RESULTS FOR AREA 50, NORTHWEST FIELD

PERIOD COVERED: April – May, 1997

SUMMARY

This report summarizes the results of the initial period of lizard trapping conducted at the Area 50 project site in Northwest Field, Guam. The Division of Aquatic and Wildlife Resources (DAWR) will soon attempt to remove brown tree snakes (*Boiga irregularis*) from the site, which will permit the eventual release of Guam rails (*Gallirallus owstoni*) and other native endangered species. Deer and feral pigs will also be eradicated from the area to allow recovery of plant communities.

The study described in this report is the first phase of a project to gather baseline data on changes in the occurrence and densities of lizards in Area 50 before, during, and after the removal of brown tree snakes. Plans call for lizard trapping to be repeated at intervals of 4-6 months to assess changes in abundance resulting from snake removal. Campbell (1996) documented increases in the abundance of the introduced skink *Carlia fusca* and the geckos *Hemidactylus frenatus* and *Lepidodactylus lugubris* after snake eradication was achieved on two 1-ha study plots at another site in Northwest Field, but failed to notice a significant change in numbers of the skink *Emoia caeruleocauda*. He also reported increases in snout-vent lengths of all lizard species following snake removal. Our study will attempt to determine if similar changes are observable in lizard populations at a larger 23-ha location using less intensive study techniques than those of Campbell (1996).

METHODS

Lizard abundance was assessed using sticky traps placed along four transects (Transects A-D) radiating from the center of Area 50 (Figure 1). These coincided with the trap lines used for small mammal surveys (G. Beauprez, DAWR, unpubl. data). Lizard traps (Victor Mouse Glue Traps, Woodstream Corp., Lititz, PA) measuring 12 by 16 cm in adhesive surface area were set at 12 stations separated by 10-m intervals along each transect. Three traps were placed at each station, with one laid on the ground, a second stapled to a nearby tree trunk at 1.2-1.8 m high, and a third attached to smaller branches (< 2.5 cm thick) or foliage at 1.2-1.8 m high. Traps were checked hourly during the day from 0830-1730 hr, once after nightfall at 1900 hr, and again the next morning at 0630 hr. Traps were kept in the same location throughout each trapping period, but were replaced with fresh units if they became fouled with debris or rain. Captured lizards were carefully removed from traps with cooking oil to avoid tail breakage and to reduce mortality. Animals were measured for snout-vent length and released outside of Area 50. *Emoia* and *Carlia* were considered adults if they had snout-vent lengths greater than 43 mm and 49 mm, respectively (McCoid 1989; M.J. McCoid cited in Campbell 1996). Tail color was also recorded for *Emoia*. Two workers took part in the study, with each assigned to one transect per day. Trapping was conducted along Transects A and C on 14 April 1997 and along Transects B and D on 13 May 1997. Standardized visual censuses were not made.

Habitat Types in Study Area

The trapping area encompassed three habitat types, as follows:

Tall limestone forest - This forest type featured a canopy greater than 5 m tall and some large tree trunks. Ground cover was moderate to fairly dense. Major plant species included *Guamia mariannae*, *Premna obtusifolia*, *Vitex parviflora*, *Aglaiia mariannensis*, *Eleaocarpus joga*, *Tristiropsis obtusangula*, *Ficus* sp., *Flagellaria indica*, *Mikania scandens*, and *Jasminum marianum*. Twenty-six trapping stations occurred in this habitat, 10 of which were located on the edge or within 5 m of a weedy opening.

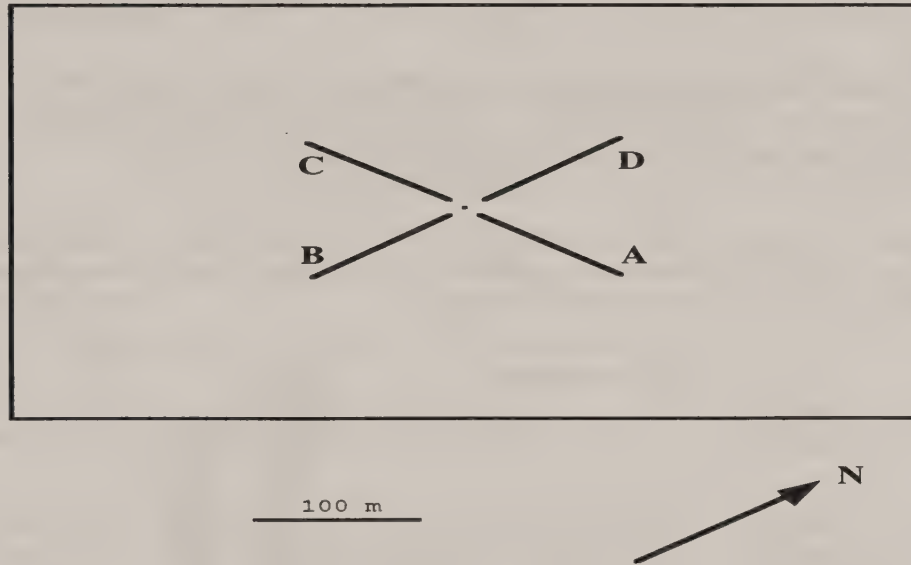


Figure 1. Locations of Transects A-D in Area 50, Northwest Field.

Short limestone forest - The forest type was 3-6 m tall with no large tree trunks present. Ground cover was moderate to fairly dense. The most common species were *Guamia mariannae*, *Premna obtusifolia*, *Vitex parviflora*, *Aglaiia mariannensis*, *Leucaena leucocephala*, *Triphasia trifolia*, *Flagellaria indica*, and *Mikania scandens*. Twenty-one stations were set in this habitat, with 12 found on the edge or within 5 m of a weedy opening.

Weedy openings - These open sites featured dense ground cover that was usually 0.3-1 m tall. *Bidens alba* was the dominant weed species, with *Momordica charantia* and *Chromolaena odorata* also relatively common. Few or no trees were present. Only one station was located in this habitat, however, 22 forested stations occurred on the edge or within 5 m of a weedy opening.

Weather conditions - Transects A and C were completed on a mostly cloudy day with several rain showers, while Transects B and D were done under hot and mostly sunny conditions. Both study nights were dry and partly cloudy.

RESULTS AND DISCUSSION

A total of 213 lizards representing four species were caught during this initial trapping session (Table 1). *E. caeruleocauda* was by far the most common species recorded, comprising 85.4% of all individuals. Other species collected included *C. fusca* (11.7%), *Gehyra mutilata* (1.4%), and *H. frenatus* (1.4%). General visual observations corroborated that *Emoia* was much more common than *Carlia* along each transect.

Table 1. Total numbers of lizards captured on Transects A-D in Area 50, April-May 1997.

Transect	<i>Emoia caeruleocauda</i>	<i>Carlia fusca</i>	<i>Gehyra mutilata</i>	<i>Hemidactylus frenatus</i>	Total
A	40	8	2	0	50
B	43	8	0	1	52
C	47	5	0	1	53
D	52	4	1	1	58
Total	182	25	3	3	213

Similar numbers of lizards were caught on each of the four transects ($G = 0.118$, $df = 3$, $P = 0.990$), with *Emoia* comprising 80.0-89.7% of the animals captured on each trap line (Table 1). Differences in weather conditions between study days did not have a noticeable effect on the numbers of skinks captured ($X^2 = 0.508$, $df = 1$, $P = 0.476$).

Size classes of captured *Emoia* and *Carlia* are shown in Figures 2 and 3. Adults comprised a large portion (76.3%) of the *Emoia* population. All brown-tailed individuals were adults, in contrast to 22.8% of the animals with blue tails.

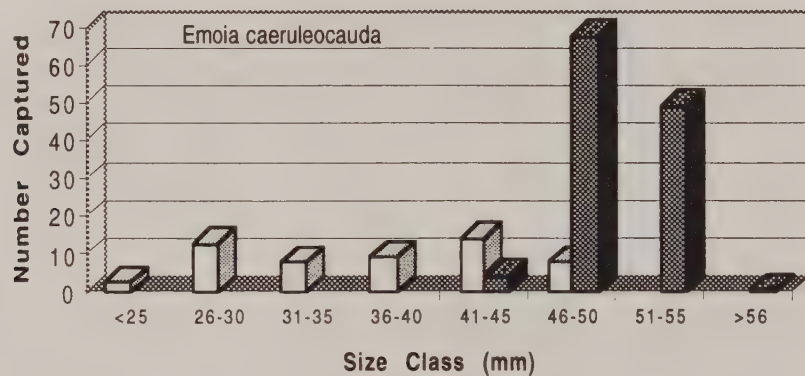


Figure 2. Size frequency distribution of *Emoia caeruleocauda* with blue tails ($n=55$; white bars) and brown tails ($n=122$; dark bars) captured on Transects A-D in Area 50, April-May 1997.

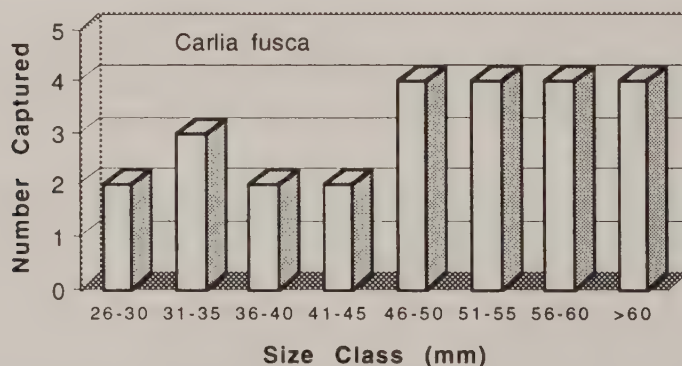


Figure 3. Size frequency distribution of *Carlia fusca* ($n=25$) captured on Transects A-D in Area 50, April-May 1997.

Additionally, 68.7% of all *Emoia* had brown tails and 31.3% had blue tails (Table 2, Figure 3). Because the population of blue-tailed *Emoia* deviated from normality (Wilk-Shapiro

test, $W = 0.918$, $P < 0.001$), a Wilcoxon 2-Sample test was used to compare size differences between the two color phases of this species. As expected, individuals with brown tails were significantly larger than those with blue tails ($Z = -10.221$, $P < 0.001$). These data support the belief that blue tails are typically found on juveniles and some older females (Wiles et al. 1990). The percent of animals with blue tails in Area 50 was lower than on the neighboring island of Rota, where this color phase comprised 57% of the *Emoia* caught in traps (Wiles et al. 1990). About half (48.0%) of the *Carlia* captured in Area 50 were adults.

Table 2. Measurements (mm) of lizards captured on Transects A-D in Area 50, April-May 1997. SVL = snout-vent length; SD = standard deviation; CV = coefficient of variation.

Species	Sample size	Mean SVL length	SD	Size range	CV
<i>E. caeruleocauda</i> (all individuals)	177	45.7	7.6	24 - 57	16.6
<i>E. caeruleocauda</i> (brown-tailed only)	122	49.7	2.4	44 - 57	4.9
<i>E. caeruleocauda</i> (blue-tailed only)	55	36.6	7.4	24 - 49	20.2
<i>C. fusca</i>	25	48.2	11.7	26 - 64	24.2
<i>G. mutilata</i>	3	50.0	3.6	47 - 54	7.2
<i>H. frenatus</i>	1	48.0	-	48	6.0

Mean capture rates ($\pm$ SD) of skinks by trap type were: ground traps, 3.7 ± 2.0 animals per day (range = 1-11 animals); branch traps, 0.4 ± 0.7 animals per day (range = 0-3 animals); and trunk traps, 0.3 ± 0.5 animals per day (range = 0-2 animals). The majority of *Emoia* were caught on ground traps (83.0%), with far fewer individuals captured on branches (9.9%) and trunks (7.1%) (Table 3). Juveniles were taken in greater numbers ($G = 14.519$, $df = 2$, $P < 0.001$) on branches and trunks (39.0%) than adults (9.5%), indicating that younger animals are more arboreal than older ones. All *Carlia* were taken on ground traps, while all geckos were collected on tree trunks.

Analyses of capture data by habitat type showed that *Emoia* abundance did not differ between forest types (adults, $G = 0.023$, $df = 1$, $P = 0.880$; adults and juveniles combined, $G = 0.062$, $df = 1$, $P = 0.804$) or with distance (< 5 m vs. > 5 m) from weedy openings (adults, $G = 0.037$, $df = 1$, $P = 0.847$; adults and juveniles combined, $G = 0.036$, $df = 1$, $P = 0.850$). Similar results were obtained for *Carlia* (both age groups combined), which was equally common in short and tall limestone forest ($G = 0.004$, $df = 1$, $P = 0.952$) and at stations near weedy openings and those farther away ($G = 2.81$, $df = 1$, $0.05 < P < 0.10$). Data from the single trap station in a weedy opening were excluded from statistical analyses because of the small sample size.

Hourly capture rates of *Emoia* and *Carlia* were greatest from 0830 to 1330 hr (Table 3, Figures 4, 5, and 6), with 83.1% of all skinks (*Emoia*, 82.4%; *Carlia*, 88.0%) caught during this period (Table 3, Figure 6). The combined capture rate for both species in all trap types peaked at 0930 hr, then generally showed a steady decline during the rest of the day. *Carlia* displayed a second peak in captures at 1330 hr, but this was perhaps an artifact of the small total number of captures for this species. All geckos were caught at 1900 hr ($n = 2$) or 0630 hr ($n = 4$).

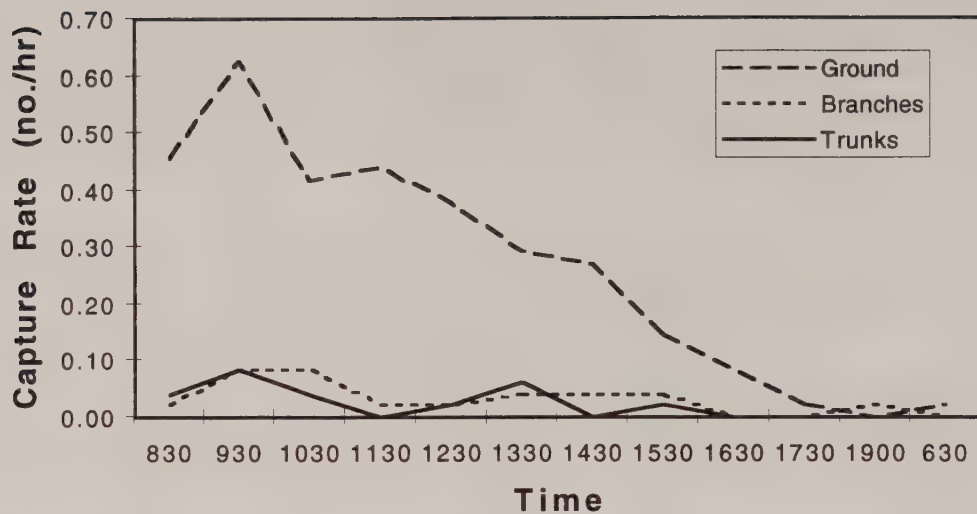


Figure 4. Capture rates (number of animals caught per hour per trap) of *Emoia caeruleocauda* in sticky traps placed on three substrates along Transects A-D in Area 50, April-May 1997.

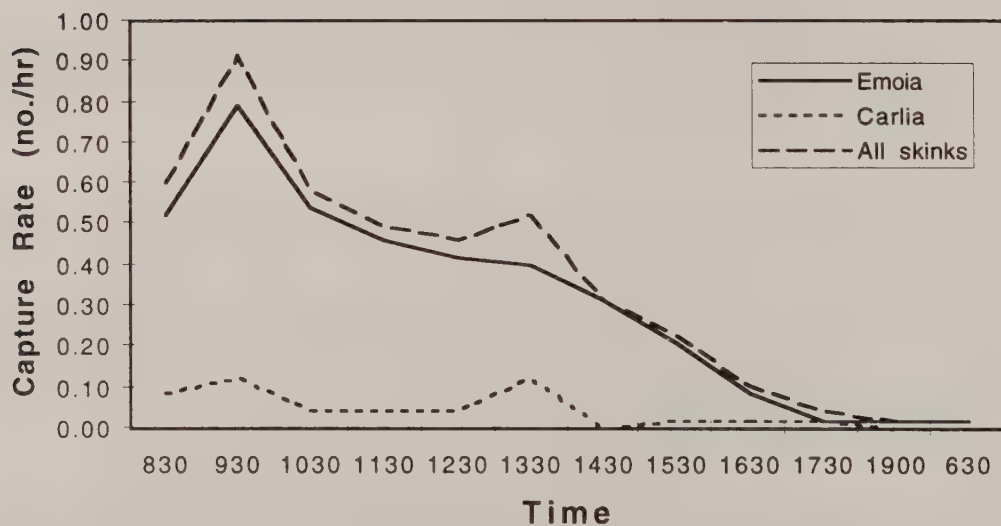


Figure 5. Capture rates (number of animals caught per hour per trap) of *Emoia caeruleocauda* and *Carlia fusca* in sticky traps placed on three substrates along Transects A-D in Area 50, April-May 1997.

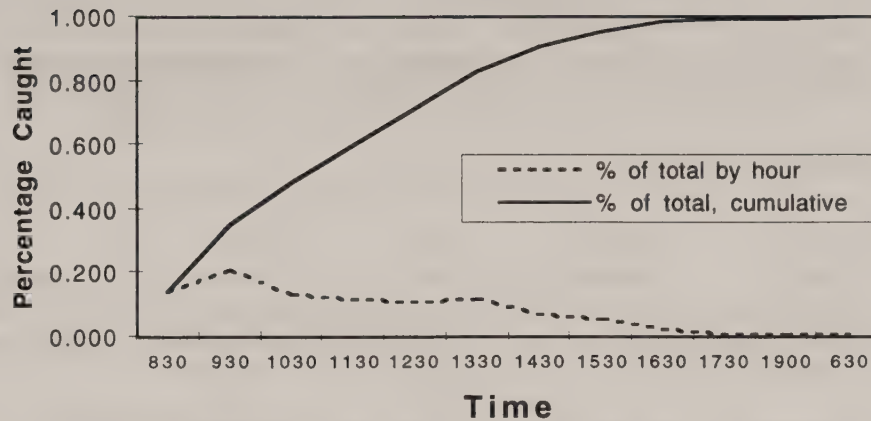


Figure 6. Hourly and cumulative captures of all skinks per hour (expressed as a percentage of all individuals caught during the day) in sticky traps on Transects A-D in Area 50, April-May 1997.

Table 3. Numbers of *Emoia caeruleocauda* (Δ) and *Carlia fusca* ($\dagger$) captured per hour in sticky traps placed on tree substrates along Transects A-D in Area 50, April-May 1997.

SPP	T.L.	830	930	1030	1130	1230	1330	1430	1530	1630	1730	1900	630	Total
Δ	G	22	30	20	21	18	14	13	7	4	1	0	1	151
Δ	B	1	4	4	1	1	2	2	2	0	0	1	0	18
Δ	T	2	4	2	0	1	3	0	1	0	0	0	0	13
Δ	A	25	38	26	22	20	19	15	10	4	1	1	1	182
$\dagger$	G	4	6	2	2	2	6	0	1	1	1	0	0	25
Σ	A	29	44	28	24	22	25	15	11	5	1	1	1	207

*Key to trap locations: G = ground; B = branches; T = trunk; A = all trap locations combined; T.L. = Trap Location; and Σ = all skinks.

ACKNOWLEDGEMENTS

Kelly Allen of the Guam National Wildlife Refuge kindly assisted with trapping on both study days.

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APPENDIX 2

LIZARD TRAPPING RESULTS FOR AREA 50, NORTHWEST FIELD

PERIOD COVERED: April 1998

SUMMARY

This report summarizes the results of the second lizard trapping session conducted in Area 50, Northwest Field, Guam, in April 1998. Initial trapping was conducted in April and May 1997 (Wiles 1998).

Environmental conditions in the study area this year were considerably different from 1997. In December 1997, Supertyphoon Paka severely damaged forests throughout northern Guam, including the one in Area 50. Canopy trees such as *Elaeocarpus joga* suffered the most damage, with most trees losing limbs and foliage and a few being blown down. The storm was followed immediately by an extended period of dry weather, which continued through April. Thus, the lizard trapping grid was considerably drier and less shady in 1998 than in 1997.

Several management programs have progressed in Area 50 during the past year. Large numbers of snakes have been removed through intensive trapping along the perimeter fenceline and grid system running through the site. About 430 snakes were removed during this period, resulting in a dramatic reduction in the number of snakes being caught by April 1998. The results of a small mammal trapping session in early April 1998 found that rat (*Rattus rattus*) numbers have begun to increase in Area 50, which coincides with the reduction of snakes (G. Beauprez, unpubl. data). Attempts to remove all deer and feral pigs from the area have continued. To date, both species have been reduced but not eradicated.

METHODS

Trapping methodology followed that described in Wiles (1998). Traps were set at the same sites as in 1997. Autotomized tails found on adhesive traps were identified to species and considered as trapped animals (tails were not found on traps in 1997). Two workers again took part in the study, with each assigned one transect per day. Trapping was conducted along Transects B and D on 14 April and along Transects A and C on 16 April.

Emoia and *Carlia* were considered adults if they had snout-vent lengths greater than 43 mm and 50 mm, respectively (McCoid 1997). The size used here for *Carlia* has been revised slightly from that used in Wiles (1998).

Weather Conditions - All transects were done under hot, mostly sunny, and breezy (10-15 mph winds) conditions. A rain shower of moderate intensity fell for several minutes in the afternoon on Transects B and D. A light rain also fell during trapping on the night of 16-17 April.

RESULTS AND DISCUSSION

A total of 299 lizards representing four species were caught during this trapping period (Table 1). *E. caeruleocauda* was again the most common species recorded, comprising

78.6% of all individuals. Other species collected included *C. fusca* (19.4%), *H. frenatus* (1.7%), and *Gehyra mutilata* (0.3%). Total numbers of lizards caught on the four transects showed much more variability than in 1997, ranging from 55 to 98 animals (Table 1), but differences between transects were not significant ($G = 6.2$, $df = 3$, $P = 0.103$). *Emoia* comprised 63.6-87.8% of the animals captured on each trap line (Table 1). The total number of *Carlia* caught was more than double last year's amount.

Table 1. Total numbers of lizards captured on Transects A-D in Area 50, April 1998.

Transect	<i>Emoia caeruleocauda</i>	<i>Carlia fusca</i>	<i>Gehyra mutilata</i>	<i>Hemidactylus frenatus</i>	Total
A	56	16	0	0	72
B	79	18	1	0	98
C	65	9	0	0	74
D	35	15	0	5	55
Total	235	58	1	5	299

Size classes of captured *Emoia* and *Carlia* are shown in Figures 1 and 2. Adults comprised a large portion (77.3%) of the *Emoia* population. All brown-tailed individuals were adults, in contrast to 47.5% of the animals with blue tails.

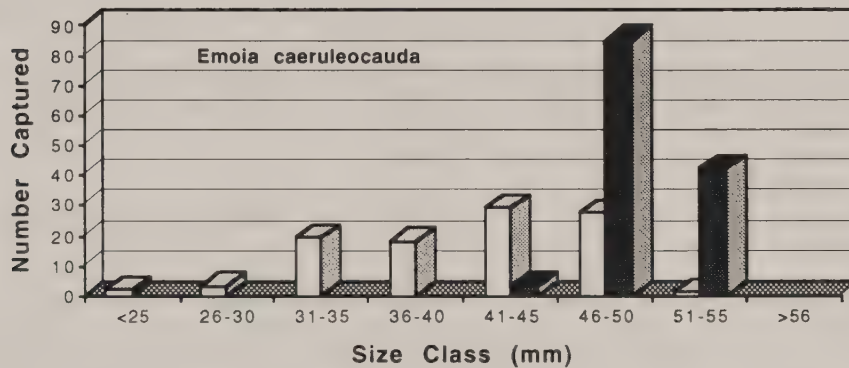


Figure 1. Size frequency distribution of *Emoia caeruleocauda* with blue tails (n=99; white bars) and brown tails (n=130; dark bars) captured on Trnasects A-D in Area 50, April 1998.

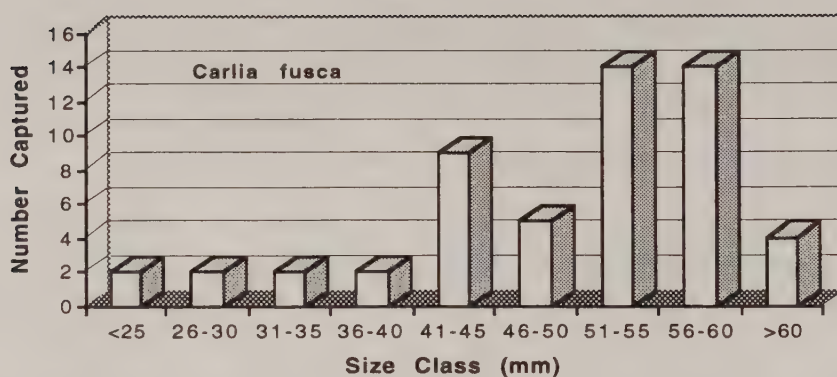


Figure 2. Size frequency distribution of *Carlia fusca* (n=54) captured on Transects A-D in Area 50, April 1998.

Additionally, 56.8% of all *Emoia* had brown tails and 43.2% had blue tails (Table 2, Figure 1). More than half (59.3%) of the *Carlia* captured were adults.

Table 2. Measurements (mm) of lizards captured on Transects A-D in Area 50, April 1998. SVL = snout-vent length; SD = standard deviation; CV = coefficient of variation.

Species	Sample size	Mean SVL length	SD	Size range	CV
<i>E. caeruleocauda</i> (all individuals)	229	45.7	6.3	23 - 55	13.8
<i>E. caeruleocauda</i> (brown-tailed only)	130	49.7	2.1	44 - 55	4.1
<i>E. caeruleocauda</i> (blue-tailed only)	99	40.5	6.2	23-51	15.3
<i>C. fusca</i>	54	49.5	9.8	24 - 62	19.7
<i>H. frenatus</i>	5	50.6	3.6	45-53	7.1
<i>G. mutilata</i>	1	45.0	-	45	-

Mean capture rates ($\pm$ SD) of skinks by trap type were: ground traps, 5.0 ± 2.5 animals per trap per day (range = 1-12 animals); branch traps, 0.7 ± 0.9 animals per trap per day (range = 0-3 animals); and trunk traps, 0.4 ± 0.8 animals per trap per day (range = 0-3 animals). Most *Emoia* were caught on ground traps (77.4%), with far fewer individuals captured on branches (13.6%) and trunks (8.9%) (Table 3). Juveniles were taken in greater numbers ($G = 9.055$, $df = 2$, $P < 0.025$) on branches and trunks (38.5%) than adults (18.1%), indicating that younger animals are more arboreal than older ones. All *Carlia* were taken on ground traps. Among *H. frenatus*, three were captured on tree trunks and two on branches. One *G. mutilata* was caught on a tree trunk.

Widespread habitat disruption in Area 50 caused by Supertyphoon Paka made analyses of habitat use by skinks difficult to conduct this year. Increased forest openness may account for the greater number of *Carlia* captured this year.

During rat trapping, a roof rat (*Rattus rattus*) was found with a freshly eaten adult *E. caeruleocauda* in its stomach. This suggests that increasing densities of rats in Area 50 associated with snake removal may possibly depress skink populations.

Table 3. Numbers of *Emoia caeruleocauda* (Δ) and *Carlia fusca* ($\dagger$) captured per hour in sticky traps placed on tree substrates along Transects A-D in Area 50, April 1998.

SP	T.L.	830	930	1030	1130	1230	1330	1430	1530	1630	1730	1900	630	Total
Δ	G	38	51	28	19	17	9	12	3	4	1	0	0	182
Δ	B	4	14	3	5	2	1	1	2	0	0	0	0	32
Δ	T	2	7	3	5	2	2	0	0	0	0	0	0	21
Δ	A	44	72	34	29	21	12	13	5	4	1	0	0	235
$\dagger$	G	19	4	15	6	5	2	3	2	1	1	0	0	58
Σ	A	63	76	49	35	26	14	16	7	5	2	0	0	293

^aKey to trap locations: G = ground; B = branches; T = trunk; A = all trap locations combined; T.L. = Trap Location; and Σ = all skinks.

ACKNOWLEDGEMENTS

Kelly Allen of the Guam National Wildlife Refuge again kindly assisted with trapping on both study days.

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Report prepared by: Gary J. Wiles

APPENDIX 3

SMALL MAMMAL SURVEY RESULTS FOR AREA 50, NORTHWEST FIELD

PERIOD COVERED: February 1997

SUMMARY

This report summarizes the initial trapping period for small mammals conducted at Area 50, Northwest Field, Anderson Air Force Base, Guam. Area 50 is an isolated 24-ha plot of native limestone forest, and is surrounded by a 2-m-tall chain link fence and old runway tarmac. The area has been proposed for the recovery of several native species including Guam rail (*Gallirallus owstoni*), Mariana crow (*Corvus kubaryi*), Micronesian kingfisher (*Halcyon cinnamomina*), and the fire tree (*Serianthes nelsonii*). Plans include the eradication of deer (*Cervus mariannus*), feral pigs (*Sus scrofa*), and brown tree snakes (*Boiga irregularis*).

The purpose of this study is to collect baseline data on small mammals in the area, including species presence and relative abundance, and to document changes in these parameters coinciding with the removal of brown tree snakes. There is the potential that the small mammal population could significantly increase following snake removal from the area (E.W. Campbell, pers. comm.). This increase could have a potential negative effect on any birds released into the area, as one rat species in particular (*Rattus rattus*) is a potential predator of both eggs and chicks (Atkinson 1985). Plans include repeating the survey every 4-6 months to document changes in occurrence and abundance of small mammals coinciding with removal of brown tree snakes.

METHODS

Surveys were conducted between 13-16 February 1997. Two transects were established that bisected each other and ran north to south and east to west (Figure 1). Each transect was 700 m in length. Trap stations were placed at 25-m intervals along each transect for a total of 28 trap stations per transect and 56 stations combined. Three snap traps were placed at each station for a total of 168 traps. One large rat trap was placed in a tree 0.5-1.5 m above the ground on the main trunk and a second large rat trap was placed on the ground. A smaller snap trap was also placed on the ground at the trap station. Target species included the roof rat (*Rattus rattus*), Polynesian rat (*Rattus exulans*), and musk shrew (*Suncus murinus*). Other potential species that could be captured include the Norway rat (*Rattus norvegicus*) and house mouse (*Mus musculus*). Traps were prebaited for 2 nights with fresh coconut. Following prebaiting, traps were baited each afternoon between 1500-1700 hr with fresh coconut dipped in peanut butter for 4 consecutive days. Traps were checked each morning between 0700-0900 hr and disabled until they were baited again that evening. Sprung traps, traps that had their bait missing, or traps that captured non-target species (i.e., hermit crabs [*Coenobita* spp.], coconut crabs [*Birgus latro*], marine toad [*Bufo marinus*]) were excluded from analysis. Trapping results (Table 1) are presented as rats caught per trap night (Dice 1931) and rats caught per trap night corrected for sprung traps (Nelson and Clark 1973).

RESULTS AND DISCUSSION

No small mammals were captured during 540 trap nights (Table 1). C. King (unpublished data) found similar densities (1 rat/100 trap nights) in an area of second growth forest in Northwest Field during June 1994. Campbell (1996) found snake densities to be as high as 34 snakes per ha on Northwest Field. This high density of snakes suggests they keep small mammal populations near zero, or at least undetectable with our trapping method. Campbell (1996) found increased rat damage to his nylon fencing on Northwest Field following removal of brown tree snakes from study enclosures. Thus, it is possible that small mammal densities will increase dramatically following removal of snakes from Area 50. Continued monitoring every 4-6 months will be necessary to document changes in occurrence and abundance of small mammals in the area in relation to removal of brown tree snakes.

Table 1. Results of snap trapping surveys to assess occurrence and abundance of small mammals in Area 50, Northwest Field, Guam, from 13-16 February, 1997. † = Transect Trap Length (m); ¢ = Trap Type; N = Nights; £ = Trap Success; æ = uncorrected/100 trap nights; and Δ = corrected/100 trap nights.

FEB DATES	†	¢	Trap	N**	£	æ	£	Δ
13	1400	RT	55		0		0	
		RG		50		0		0
		MG		43		0		0
14	700*	RT	28		0		0	
		RG		24		0		0
		MG		21		0		0
15	1400	RT	56		0		0	
		RG		55		0		0
		MG		47		0		0
16	1400	RT	54		0		0	
		RG		55		0		0
		MG		52		0		0
TOTAL				540				

Key to Trap Types: RT = Rat Tree; RG = Rat Ground; and MG = Mouse Ground.

*Only one 700 m transect was run. ** Corrected for closed traps.

ACKNOWLEDGEMENTS

Mike Ritter and Kelly Allen of the Guam National Wildlife Refuge provided traps and assisted with trapping and data collection during the six-day study period.

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APPENDIX 4

SMALL MAMMAL SURVEY RESULTS FOR AREA 50, NORTHWEST FIELD

PERIOD COVERED: April 1998

This report summarizes the second trapping period for small mammals conducted at Area 50, Northwest Field, Anderson Air Force Base, Guam. Area 50 is an isolated 24-ha plot of native limestone forest, and is surrounded by a 2-m-tall chain link fence and old runway tarmac. The area has been proposed for the recovery of several native species including Guam rail (*Gallirallus owstoni*), Mariana crow (*Corvus kubaryi*), Micronesian kingfisher (*Halcyon cinnamomina*), and the fire tree (*Serianthes nelsonii*). Plans include the eradication of deer (*Cervus mariannus*), feral pigs (*Sus scrofa*), and brown tree snakes (*Boiga irregularis*).

The purpose of this study is to collect baseline data on small mammals in the area, including species presence and relative abundance, and to document changes in these parameters coinciding with the removal of brown tree snakes. There is the potential that the small mammal population could significantly increase following snake removal from the area (E.W. Campbell, pers. comm.). This increase could have a potential negative effect on any birds released into the area, as one rat species in particular (*Rattus rattus*) is a potential predator of both eggs and chicks (Atkinson 1985). Plans include repeating the survey every 4-6 months to document changes in occurrence and abundance of small mammals coinciding with removal of brown tree snakes.

METHODS AND RESULTS

Surveys were conducted between 7-10 April 1998. Trapping methodology followed that described in Beauprez (1998). A total of 11 *R. rattus* were captured during 479 trap nights, as compared to no captures in 1997 (Table 1; Beauprez 1998). Eight of the 11 captures were made in rats traps set on the ground.

ACKNOWLEDGEMENTS

Mike Ritter and Kelly Allen of the Guam National Wildlife Refuge provided traps and assisted with trapping and data collection during the study period.

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Table 1. Results of snap trapping surveys to assess occurrence and abundance of small mammals in Area 50, Northwest Field, Guam, 7-10 April 1998. † = Transect length (m); TT = Trap Type; TN = Trap Nights; £ = Number of rats caught. Trap Success: ¢ = uncorrected/100 trap nights; Δ = corrected/100 trap nights.

APRIL DATES	†	TT	TN*	£	¢	Δ
7	1400	RT	52	2	3.85	3.70
		RG	24	2	8.33	5.00
		MG	19	0	0	0
8	700	RT	51	0	0	0
		RG	42	3	7.14	6.12
		MG	31	0	0	0
9	1400	RT	51	1	1.96	1.87
		RG	42	2	4.76	4.08
		MG	34	0	0	0
10	1400	RT	52	0	0	0
		RG	43	1	2.33	2.02
		MG	38	0	0	0
TOTALS			479	11	2.30	1.91

Key to Trap Types: RT = Rat Tree; RG = Rat Ground; and MG = Mouse Ground.

*Corrected for closed traps.

